# SELECTED

# **SWATER**RESOURCES ABSTRACTS



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# SELECTED WATER RESOURCES ABSTRACTS

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VOLUME 24, NUMBER 3 MARCH 1991

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

### **PREFACE**

elected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the Water Resources Thesaurus. The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several services of the Water Resources Scientific Information Center. The cumulative SWRA file from 1968 and monthly updates are available also in magnetic tape through lease from NTIS.

THE WATER RESOURCES SCIENTIFIC INFOR-MATION CENTER DOES NOT PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific Information Center U.S. Geological Survey MS 425 National Center Reston, VA 22092

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includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

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08 ENGINEERING WORKS

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University Coll., London (England). Dept. of Civil Engineering. For primary bibliographic entry see Field 5F. W91-02145

### 2. WATER CYCLE

### 2A. General

SIMILARITY AND LENGTH SCALE FOR SPA-TIALLY VARIED OVERLAND FLOW. Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-02189

NORTHEAST GLACIAL AQUIFERS. For primary bibliographic entry see Field 2F. W91-02280

UPLAND RUNOFF AS A MAJOR SOURCE OF RECHARGE TO STRATIFIED DRIFT IN THE GLACIATED NORTHEAST.

Geological Survey, Bow, NH. Water Resources

For primary bibliographic entry see Field 2F. W91-02282

ESTIMATION OF WATER AVAILABLE FOR RECHARGE TO SAND AND GRAVEL AQUIFERS IN THE GLACIATED NORTHEASTERN UNITED STATES.

Geological Survey, Albany, NY. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-02283

USE OF OXYGEN-18 AND DEUTERIUM MASS-BALANCE ANALYSIS TO EVALUATE INDUCED RECHARGE TO STRATIFIED-DRIFT AQUIETRS.

Geological Survey, Albany, NY. Water Resources

For primary bibliographic entry see Field 2F. W91-02287

STATE-OF-THE-ART OF HYDROLOGY AND HYDROCEOLOGY IN THE ARID AND SEMI-ARID AREAS OF AFRICA.

Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990, 990p. Edited by Misganaw Demissie and Glenn E. Stout.

Descriptors: \*Africa, \*Arid lands, \*Arid-zone hydrology, \*Geohydrology, \*Hydrology, \*Sahel, \*Semiarid lands, \*Symposium, Developing countries, Drought, Floods, Sudan, Water resources development, Water resources management.

The Sudan-Sahel is the southern expanse of the desert in West Africa that for many centuries has been subject to frequent droughts and flash floods. The situation is little changed today. The countries of Sudan-Sahel continue to try to juggle a precarious supply of water for municipal, industrial, and agricultural uses with their rapidly expanding populations. A significant barrier to water supply planing in this part of Africa is the lack of basic hydrological information. This volume includes presentations from a seminar held in Burkina Faso from 18-23 February 1989. The purpose of the seminar was to assemble knowledge on hydrogeo-

logy and hydrogeology in the arid and semiarid areas of Africa and make it available to the countries in this region as they seek long-range solutions to their water management questions. The more than 81 presentations cover various aspects of hydrology, hydrogeology, and water engineering appropriate to these regions, including: general and theoretical hydrology of the area; regional surface water hydrology; soils and runoff; drought and climatic factors in regional hydrology; information systems and comouter anoplications suitable and climatic factors in regional hydrology; infor-mation systems and computer applications suitable for water resources management in the Sahel; mathematical modeling; irrigation; aquifer charac-teristics; natural recharge of aquifers; village water supply systems; water exploration methods and instrumentation; groundwater resources; effects of pollution on aquifers and surface water quality; control of water-borne disease; hydrologic educa-tion programs; and agricultural water managetion programs; and agricultural water management. (See W91-02289 thru W91-02369) (Roche ter-PTT) W91-02288

DEVELOPMENT OF THEORETICAL HY-DROLOGY IN WEST AFRICA (DEVELOPPE-MENT DE L'HYDROLOGIE THEORIQUE EN AFRIQUE DE L'OUEST).

Universite Nationale du Benin, Cotonou. Dept. de Mathematiques.

Mathematiques.

A. Abel.

IN: The State-of-the-Art of Hydrology and Hydrogoology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 1-14, 1 fig, 2 tab, 15 ref. English

Descriptors: \*Drought, \*Model studies, \*Rainfall-runoff relationships, \*West Africa, Climates, Math-ematical models, Theory.

rmancal models, inteory.

Theoretical hydrology as it applies to West Africa is analyzed with respect to persistent droughts and rainfall-runoff relationships. Several features are required for proper understanding of hydrologic phenomena, including: continuously operated observation networks, thoroughly controlled basic data, and mathematical models incorporating dynamics, stochastic features, and non-linearity of the natural environment. The development of theoretical models associating direct observations and model concepts can be done within an appropriate working group. Validation of existing observational records and improvement of the acquisition of new data are important. The value of the interaction between theoretical and practical hydrology must be recognized to obtain a complete understanding of the hydrology of West Africa. (See also W91-02288) (Rochester-PTT)

HYDROLOGICAL MODELLING FOR WATER MANAGEMENT IN ARID AND SEMI-ARID AREAS OF AFRICA. Institute of Hydrology, Wallingford (England). R. J. Moore.

IN. The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 35-46, 5 fig, 1 tab, 13 fig.

Descriptors: \*Arid lands, \*Model studies, \*Rainfall-runoff relationships, \*Semiarid lands, Decision making, Evaporation, Hydrologic models, Infiltration, Mathematical models, Vegetation, Water re-

Rainfall, evaporation, and runoff formation processes operating in arid and semi-arid areas differ from those in humid temperate regions. The special nature of hydrological processes in a raid and semi-arid areas are reviewed in relation to the structure, data requirements, and accuracy of hydrological models for water management in such areas. Evaporation in the arid zone, rainfall in the arid zone, hydrologic models and rainfall variability, a conceptual rainfall-runoff model for semi-arid basins, drought management and decision support systems

are considered. Recommendations for direction of future efforts in hydrological modeling of surface water resources in the arid and semi-arid areas of Africa are as follows: (1) further research on evaporation estimation in drylands that incorporates water venerations. oration estimation in drylands that incorporates water use-vegetation growth models; (2) evaluation of the combined use of radar, satellite, and gauge measurements of rainfall; (3) rainfall-runoff models that explicitly account for spatially varying rainfall, even in a probabilistic way; (4) a field experiment to examine transmission losses in detail, using infiltrometers located along a wadi bed, to provide information to support predictive modeling of basin runoff; (5) give more attention to the decision making framework within which models are used and to the choice of an appropriate model prescription; (6) development of decision support systems for water resource management in semi-arid areas; and (7) seeking opportunities for demand management of water resource systems to sustain essential water supplies throughout a drought. (See also W91-02288) (Rochester-PTT) W91-02291

CIEH'S CONTRIBUTION TO THE DEVELOP-MENT OF HYDROLOGY IN ARID AND SEMI-ARID AREAS IN AFRICA (CONTRIBUTION DU CIEH AU DEVELOPPEMENT DE L'HY-DROLOGIE DANS LES ZONES ARIDES ET SEMI-ARIDES D'AFRIQUE).

Comite Interafricain d'Etudes Hydrauliques, Oua-gadougou (Burkina Faso). Dept. of Hydrology. J. P. Triboulet.

J. P. Indouet.

In: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 47-67, 12 fig, 29 ref. English summa-

Descriptors: "Africa, "Arid lands, "Data collections, "Hydrologic data collections, "Information systems, "Inter-African Committee for Hydraulic Studies, "Semiarid lands, Developing countries, Floods, Frequency analysis, Hydrologic models, Publications, Storms, Urban hydrology, Water re-

For about 30 yr, the Inter-African Committee for Hydraulic Studies (CIEH) has provided important leadership in hydrology of West and Central Africa. The main objective has been making available climatological and hydrological data for engineers of water resources projects. Computerized files of daily rainfall for all 13 member countries have been prepared from the origin of the actions. have been prepared from the origin of the stations until 1965. Extension of these files to 1980 is under until 1965. Extension of these files to 1980 is under way. Regional frequency analysis of the annual maximum daily rainfall has been carried. Maps showing 10-yr and 100-yr daily precipitation values are available. Monthly evapotranspiration values, calculated by Turc formula and mapped, were published in 1972. Other studies have been carried out on artificial precipitation, reduction of water losses by evaporation, and drought persistcarried out on artificial precipitation, reduction of water losses by evaporation, and drought persistence in West Africa. CIEH has supported some national hydrological services in the development of data bank software for use on a microcomputer. CIEH has published hydrological monographs on large river basins prepared by ORSTOM. In hydrology, the main activity has been the development of methodology for studying exceptional floods and annual runoff in small rural catchments. The information collected by ORSTOM on representative catchments was used to draw deterministic relationships between flow (10-vr peak flow tic relationships between flow (10-yr peak flow and annual flow) and storm event characteristics, and annual flow) and storm event characteristics, geomorphology, and infiltration capacity of the catchment area. Another method based on a statistical approach was developed in 1983. A large program in urban hydrology began in 1976 with measurements on 25 catchment areas in 6 main cities of West Africa. These results will permit the design of a rainfall-runoff model adapted to urbanized areas. CIEH also is involved in training engineers and terchnicians concerned with water reized areas. Cleri also is involved in training engi-neers and technicians concerned with water re-sources assessment and management in rural and urban areas. The Information and Documentation Center of CIEH collects specialized references in

### Group 2A-General

water resources and provides support for bibliog-raphy. (See also W91-02288) (Author's abstract) W91-02292

ADVANCES TOWARDS WATER RESOURCES DEVELOPMENT THROUGH HYDROLOGI-CAL TRAINING AND EDUCATION. Vizgazdalkodasi Tudomanyos Kutato Intezet, Bu-

dapest (Hungary).
For primary bibliographic entry see Field 6E.
W91-02293

CONTRIBUTION OF CIEH IN THE FIELD OF HYDROGEOLOGY (CONTRIBUTION DU CIEH DANS LE SECTEUR DE L'HYDROLO-

Comite Interafricain d'Etudes Hydrauliques, Oua-gadougou (Burkina Faso). Dept. of Hydrology. C. Di Luca.

C. Di Luca.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 90-115, 1 fig. 6 tab. English summa-

Descriptors: \*Africa, \*Geohydrology, \*Inter-African Committee for Hydraulic Studies, \*Mapping, \*Water resources management, Aquifers, Developing countries, Recharge, Sampling,

Since its inception CIEH (le Comite Interafricain d'Etudes Hydrauliques or Inter-African Committee for Hydraulic Studies) has had an important tee for Hydraulic Studies) has had an important role in hydrogeology. A series of maps for water resources management was drawn for the 13 coun-tries of CIEH during the period 1976-1982. These maps synthesize all acquired knowledge and give the national authorities valuable information on exploitable storages and water quality to support development projects. Development of computer-assisted cartography using the data bases already available in the member states demonstrated the advantages of evolutionary mapping. With the de-velopment of air-hammer drilling, CIEH directed velopment of air-hammer drilling, CIEH directed an important part of its activity to understanding the water resources in crystalline bedrock and to the methodology of borehole location in these formations. Several areas are appropriate targets for future efforts, including: estimation of aquifer recharge in bedrock using observation of experimental basins and isotope studies to establish mathematical models; understanding of regional faults and adjusting geophysical methods for discontinuous aquifers; improved use of radon prospecting; combatting the problems of 'sanding-up' of wells; use of computer data bases for aquifer managecomoating the proteins or sanding-up of weis; use of computer data bases for aquifer manage-ment; and national organization of collection and processing of hydrogeological data. (See also W91-02288) (Rochester-PTT)

TOWARDS A REGIONAL WATER RESOURCE STUDY OF ARID AND SEMI-ARID AFRICA.

STUDY OF ARID AND SEMI-ARID AFRICA. Institute of Hydrology, Wallingford (England).

A. Bullock, and A. Gustard.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 118-125, 5 fig, 6 ref.

Descriptors: \*Africa, \*Arid lands, \*Discharge ca-pacity, \*Rainfall-runoff relationships, \*Regional planning, \*Semiarid lands, \*Water resources devel-opment, Catchment areas, Estimating equations, Soils, Ungaged streams, Zimbabwe.

Regionalization techniques generally are poorly developed in the arid and semi-arid regions of Africa compared with temperate regions. This is because of the relative scarcity of hydrological records, difficulties in derivation of appropriate flow statistics, and the absence of established extrapolation procedures. An analysis of data from 49 catchments in central Zimbabwe reveals a pedological control upon the shape of standardized flow duration curves. When combined with a regional

rainfall/runoff relationship for southern Africa, a provisional procedure is established for the estima-tion of ungauged sites of discharges with particular exceedance probabilities. Streams in moderately exceedance probabilities. Streams in moderately shallow to moderately deep soils are characterized by a sustained flow regime compared those in shallow to moderately shallow soils, which are ephemeral and experience zero flows for approximately 18-36 days per year on average. A regional anifall/runoff relationship has been calibrated using data from 171 catchments in four southern African countries. This enables preliminary estimates of the average daily flow at ungauged sites, which may then be used to rescale the standardized flow duration curves. In combination this procedure, although provisional, could prove valuable in enabling estimates of discharges with a given exceedance probability in southern Africa. Several opportunities exist for improving and developing this procedure. (See also W91-02288) (Rochester-PTT) W91-02295 91-02295

SURFACE FEATURES: ONE OF THE KEY ELEMENTS OF SAHELIAN HYDROLOGY (LES ETATS DE SURFACE: UNE DES CLEFS

(LES ETATS DE SURFACE: UNE DES CLEFS DE L'HYDROLOGIE SAHELIENNE). Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Lome (Togo). Centre ORSTOM du Togo.

A. Casenave, and C. Valentin.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Il-linois. 1990. p 135-147, 2 fig, 1 tab, 23 ref. English summary. ımmarv.

Descriptors: \*Africa, \*Arid lands, \*Infiltration, \*Mapping, \*Rainfall-runoff relationships, \*Sahel, \*Soil properties, Data acquisition, Floods, Remote sensing, Simulation.

Rainfall simulation experiments have been implemented in the Sahelian zone for more than 10 years is related to worsening water management prob-lems. They have led to the assessment and compar-ison of the various factors influencing infiltration and runoff in this climatic zone. The prevailing role of surface features, including vegetative cover, faunal activity, surface roughness, and surface crust, was evident. The analysis of the process and the factors involved in surface crusting, coupled with the identification of peculiar microlayers, led to the definition of a morphogenetic typology of nine major types of Sahelian crusts. In addition, grass or crop cover, faunal activity, and tillage were taken into account to characterized 11 main unit surfaces. This morphological approach cou-pled with rainfall experiments enabled specific hy-draulic parameters to be associated with each unit uratine parameters to be associated with each unit surface. At a higher scale level, the concept of 'surface features' was proposed. This refers to the combination of several map unit surfaces and has been used as the basis for an original mapping nethod. Mapping units were considered as homo-geneous both in terms of dynamics and hydraulic behavior. Also, remote sensing was used satisfacto-rily for mapping remote watersheds. Low-frequen-cy floods were determined with a reasonable accucy noos were determined with a reasonate accuracy and results could be derived to unstudied watersheds, provided remote sensing had been combined with the rainfall experiments data and a small time step modelling. (See also W91-02288) (Author's abstract) 91-02297

WATER LOSSES IN THE NILE BASIN.
International Inst. for Hydraulic and Environmental Engineering, Delft (Netherlands).
M. M. A. Shahin.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 148-157, 3 fig, 2 tab, 11 ref.

Descriptors: \*Africa, \*Arid lands, \*Drought, \*Evapotranspiration, \*Hydrologic budget, \*Nile

River Basin, \*Water loss, Agricultural water, Egypt, Irrigation, Lakes, Storage reservoirs, Sudan, Swamps.

The water shortage in Africa is becoming so acute that it has begun to threaten the entire continent. From an annual rainfall of about 20,000 billion cu m, only some 2,500 billion cu m comprise the long-term annual flow in all African rivers. Only 10% of the stream flow is used for irrigation. Slightly less than half the irrigated land in Africa lies within less than half the irrigated land in Africa lies within the Nile basin. Permanent and temporary swamps in Africa occupy an area estimated at 340,000 sq km, causing the loss of some 500 billion cu m/yr, more than 10% of which is lost in swamps of the Nile basin alone. The increase in number and area of storage reservoirs in the basin is leading to the loss of substantial volumes of water each year. Irrigated agriculture cannot be expanded unless some of the water lost is saved. Proper design of conservation schemes must be based on accurate estimates of the losses. Water losses for the Nile basin are reported here for swamps and storage basin are reported here for swamps and storage reservoirs. Total water losses via these two fea-tures are estimated at 105 billion cu m/yr, about 13 tures are estimated at 105 billion cu m/yr, about 13 billion of which is accounted for storage reservoirs, the rest being lost by swamps and lakes. Adding these losses to the irrigation losses of 75 billion cu m/yr in Egypt and the Sudan yields a total of 179 billion cu m/yr, or roughly 11% of the rainfall on the Nile basin. (See also W91-02288) (Rochester-PTT)

ANALYSIS OF DROUGHT IN ETHIOPIA BASED ON NILE RIVER FLOW RECORDS. Illinois State Water Survey Div., Champaign

M. Demissie.

M. Demissie.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 158-168, 7 fig. 2 ref.

Descriptors: \*Arid lands, \*Drought, \*Ethiopia, \*Low flow, \*Nile River, Long-term studies, River flow, Time series analysis.

The drought situation in Ethiopia, which has resulted in serious famines in 1972-1973, 1982-1983, and 1987-1988, has been attributed to a short-term (7-10 yr) cycle of recurring droughts. Whether this is true was assessed by examining available records of the flow of the Nile River from 1912 until 1985. Examination of these records shows a much more serious and long-term trend. The Nile River records show that the most recent three droughts are associated with a long-term drying period that started in the mid-1960s. With the exception of four years, the flow of the Nile has been below normal since 1965. Not only has the lowest annual flow of the Nile since 1912 been recorded within this dry period, but six of the seven lowest annual this dry period, but six of the seven lowest annual flows occurring since 1912 occurred since 1965. A quick recovery from this trend appears unlikely. (See also W91-02288) (Author's abstract) W91-02299

EVAPORATION FROM FREE WATER SUR-FACES IN THE SUDANO-SAHELIAN CLI-MATE (L'EVAPORATION DES NAPPES D'EAU LIBRE EN CLIMAT SOUDANO-SAHE-

Institut Français de Recherche Scientifique pour le Developpement en Cooperation, Montpellier. Centre de Montpellier.

For primary bibliographic entry see Field 2D. W91-02300

ELECTRONICS AND INFORMATICS FOR THE ACQUISITION OF HYDROMETEOROLOGICAL DATA: A GREAT TOOL FOR WATER RESOURCE MANAGEMENT IN THE WATER RESOURCE MANAGEMENT IN THE SAHEL (ELECTRONIQUE ET INFORMATI-QUE POUR L'ACQUISITION DES DONNEES HYDROMETEOROLOGIQUES, UN OUTIL PRODIGIEUX POUR LA GESTION DES RES-SOURCES EN EAU DANS LE SAHEL).

### General-Group 2A

Laboratoire General de Recherches, Brussels (Bel-

gium). For primary bibliographic entry see Field 7B. W91-02303

PREDETERMINATION OF FLOODS IN SMALL SAHELIAN BASINS UNDER 10 SQUARE KILOMETERS (LA PREDETERMINATIONE DES CRUES SUR DES PETITS BASSINS SAHELIENS INFERIEURS A 10 KM2), Institut Francais de Recherche Scientifique pour le Developement en Cooperation, Montpellier. Centre de Montpellier.
For primary bibliographic entry see Field 2E.
W91-02305

PROBLEM OF WATER BALANCE MODEL-LING UNDER SEMI-ARID CONDITIONS, Oslo Univ. (Norway). Inst. of Geophysics. For primary bibliographic entry see Field 7C. W91-02307

SOME EXAMPLES OF IMPORTANT PROB-LEMS CONNECTED TO RAINFALL-RUNOFF MODELLING IN SEMI-ARID ZONE.

Lund Univ. (Sweden). Dept. of Water Resources Engineering.
For primary bibliographic entry see Field 7C.
W91-02308

USE OF A DISTRIBUTED MODEL OF A SMALL SAVANNAH CATCHMENT (BOORO-BOROTOU, IVORY COAST) UTILISATION D'UN MODELE DISTRIBUE SUR UN PETIT BASSIN VERSANT DE SAVANE (BOORO-BOROTOU, COTE D'IVOIRE). Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Montpellier. Centre de Montpellier. Centre de Montpellier.

Centre de Montpellier.
P. Chevallier, and G. Girard.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 280-290, 6 fig, 1 tab, 10 ref. English summary.

Descriptors: \*Hydrologic budget, \*Hydrologic models, \*Ivory Coast, \*Model studies, Booro-Bor-otou catchment, Climatology, Geohydrology, Mathematical models, Performance evaluation,

The Hyberbav Program is located on a small catchment in the northwest of the Ivory Coast. Fine observations have been made on a 136-ha area from 1984 to 1988 on all the parameters that may affect water balance (hydrology, climatology, soil science, hydrogeology, and botany). The 'coupled model,' developed jointly by ORSTOM and the Ecole Nationale Supericure des Mines de Paris EXAME INMIDIAGE SUperieure des Mines de Paris seems to be a good tool for incorporating all these data into a model representing the superficial and internal water exchange transfers. (See also W91-02288) (Author's abstract)

GLOBAL MODELLING OF THE RAIN-RUNOFF RELATIONSHIP: A TOOL FOR EVALUATION OF WATER RESOURCES (MO-DELISATION GLOBALE DE LA RELATION PLUIE DEBIT: DES OUTILS AU SERVICE DE L'EVALUATION DES RESSOURCES EN EAU). Lettint Erangie de Joharch Scientifous produ Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Abidjan (Ivory Coast), Centre ORSTOM d'Adiopodoume. For primary bibliographic entry see Field 2E. W91-02349

SCIENTIFIC AND TECHNICAL EVALUATION OF MATHEMATICAL MODELS IN THE PLANNING DESIGN AND OPERATION OF HYDROSYSTEMS IN AFRICA. New Tech International Inst., Dar es Salaam (Tan-

For primary bibliographic entry see Field 2E.

W91-02350

USE OF PERSONAL COMPUTERS FOR THE ANALYSIS AND MANAGEMENT OF HYDRO-METEOROLOGICAL AND GROUNDWATER

DATA.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 7C.
W91-02351

HYDROLOGICAL NETWORK, DATA BANKS, AND TELETRANSMISSION (RESEAUX HYDROLOGIQUES, BANQUES DE DONNEES INFORMATISEES ET TELETRANSMISSION), Office de la Recherche Scientifique et Technique Outre-Mer, Montpellier (France). For primary bibliographic entry see Field 7B. W91-02352

SYSTEMS ENGINEERING APPROACH TO SOLUTIONS OF DROUGHT IN DEVELOPING COUNTRIES: THE CASE OF TANZANIA.

zania).

A. R. Mfutakamba.

IN: The State-of-the-Art of Hydrology and Hydrogology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 889-901, 22 ref.

Descriptors: \*Developing countries, \*Drought, \*Model studies, \*Political aspects, \*Public policy, \*Systems engineering, \*Tanzania, \*Water supply, Economic aspects, Management planning, Monstructural alternatives, Performance evaluation, Rural areas, Social aspects, Urban areas.

A drought model was developed and applied to Tanzania as an example of the developing world. Factors affecting millions of poor people include climate, politics, economics, and the lack of technological capabilities to offset drought effects. The model critically examines government policy, social and technological constraints in the implementation of must users supply, social and technological constraints in the implementation of must users supply, social and technological constraints in the implementation of must users supply, social and technological constraints in the implementation of must users supply sociation in the contraction of the contract of the con social and technological constraints in the implementation of rural water supply, sanitation, irrigation, and energy systems based on a United States Agency for International Development (USAID) study. Contrary to the study, there seems to be no contradiction between policy and program implementation. Technological constraints seem to prevail. The model proposes a systems engineering approach to analyze the shortcomings and proposes multi-disciplinary solutions to the water economy sectoral problem. The extent of comminent on the part of the government and its nationals to the rural water supply programs is assessed. Due to the global power structure, the urban water supply and sanitation systems are still more fa-Due to the global power structure, the urban water supply and sanitation systems are still more fa-vored than those in the rural areas where the majority live. The lack of participation in the study by women missed key subjects for research work. The focus has never been on the key foreign exchange earners: the rural poor. Even the budget exchange continues to favor urban areas not only exchange earners: the rural poor. Even the budget structure continues to favor urban areas, not only in health services, roads, housing, and education, but in water supply and sanitation. The Tanzanian study had numerous methodological shortcomings, including: too many water professionals on the study team, lack of a local economist on the team, lack of a boalance between village water supply and agricultural water supply emphasis, lack of participation by the local academic community, and the lack of an overall model to guide study design and execution. (See also W91-02288) (Rochester-PTT) W91-02361

FREQUENCY-RELATED TEMPORALLY AND SPATIALLY VARIED RAINFALL.
Army Engineer District, Fort Worth, TX.
For primary bibliographic entry see Field 2B.
W91-02528

HYDROGEOCHEMICAL AND ISOTOPICAL INVESTIGATIONS OF GROUND AND SURFACEWATERS AT THE SOUTHWEST EDGE OF THE HARZMOUNTAINS DURING AN AR-

TIFICIAL INDUCED HIGH WATER (HYDRO-GEOCHEMISCHE UND ISOTOPENCHE-MISCHE UNTERSUCHUNGEN AN GRUND UND OBERFLACHENWASSERN AM SUD-WESTRAND DES HARZES WAHREND EINES KUNSTLICH INDUZIERTEN HOCH-WASSERS)

WASSERS).

Goettingen Univ. (Germany, F.R.). Sedimentpetrographisches Inst.

For primary bibliographic entry see Field 2K. W91-02545

EFFECT OF FIELD-SCALE SOLUTE INFILTRATION INTO GROUNDWATER ON SURFACE WATER QUALITY.

Royal Inst. of Tech., Stockholm (Sweden). Dept. of Hydraulics Engineering. For primary bibliographic entry see Field 5B. W91-02683

INFLUENCE OF PRECIPITATION ON THE QUALITY OF KARST GROUNDWATER IN INDUSTRIAL ZONES.

Belgrade Univ. (Yugoslavia). Faculty of Mining and Geology.
For primary bibliographic entry see Field 5B.
W91-02686

BIOSPHERE AND CLIMATE.

Akademiya Nauk SSSR, Leningrad. Inst. for Lake Research.

K. Y. Kondratyev. Atmosfera ATMSEF, Vol. 3, No. 3, p 165-182, July 1990. 3 tab, 38 ref.

Descriptors: \*Atmospheric water, \*Climatic changes, \*Climatology, \*Greenhouse effect, \*Hydrologic cycle, Atmospheric circulation, Deserts, Evapotranspiration, Forest hydrology, Geochemistry, Mathematical models, Numerical analysis, Parametric hydrology, Precipitation, Snow cover, Soil water, Solar radiation, Surface water, Vegeta-

Atmospheric variations, which determine both the incoming solar radiation and greenhouse effect, are key factors of climate change. A new stage of climate theory development has begun which deminate theory development has constrates the need to more adequately consider land surface processes as well as the interaction between biogeochemical cycles and climate; the biosphere must be considered as a component of between totage chemical cycles and chinate; interest of the 'atmosphere-hydrosphere-cryosphere-lithosphere-chipsphere-chi cover (tropical forests, mid-latitude forests, deserts, grass cover, etc.) and its interactive connection with conditions in the atmosphere and soil. Preliminary calculations show marked effects of tropical deforestation and desertification. Sea ice cover, detorestation and descrittication. Sea ice cover, continental snowcover, and permafrost play important roles in cryosphere component of the climate system. The key role in the formation of climate and biospheric functioning is played by the global water cycle. (Fish-PTT)

SENSITIVITY OF THE SURFACE HYDROLOGY TO THE COMPLEXITY OF THE LAND-SURFACE PARAMETERIZATION SCHEME

Macquarie Univ., North Ryde (Australia). School of Earth Sciences.
For primary bibliographic entry see Field 7C.
W91-02804

### Group 2A-General

RUNOFF GENERATION IN A SANDY AREA-THE NIZZANA SANDS, WESTERN NEGEV,

Hebrew Univ., Jerusalem (Israel). Inst. of Earth

A. Yair. Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 7, p 597-609, November 1990. 10 fig, 3 tab. 28 ref.

Descriptors: \*Dunes, \*Geomorphology, \*Israel, \*Rainfall-runoff relationships, \*Sand, \*Storm runoff, Playas, Rainfall.

The study of present-day geomorphic processes in the Nizzana sand field in Western Negev, Israel, is very limited. Sprinkling experiments were con-ducted over the lower part of vegetated and crust-ed linear dunes as well as over flat playa surfaces that appear in the interdune corridors. Data obthat appear in the interdune corridors. Data ob-tained show that these two surface units respond quickly to rainstorms. Runoff generation can be expected for any storm exceeding 2-3 mm and runoff coefficients are high. When the topsoil algal crust, 1 to 2 mm thick, is removed from the surface crust, I to 2 mm thick, is removed from the surface of the dune, infiltration increases drastically and eliminates any possibility of runoff generation under present-day rainfall conditions. This data may be of great help in the understanding of the geomorphology and sedimentary sequence of the corridors separating linear dunes. (Author's abstract) W91-02811

RAINFALL AND SURFACE KINEMATIC CON-DITIONS OVER CENTRAL AMAZONIA DURING ABLE 2B.

James Madison Univ., Harrisonburg, VA. Dept. of Geology and Geography.
For primary bibliographic entry see Field 2B.
W91-02841

IDENTIFICATION OF LARGE-SCALE SPA-TIAL TRENDS IN HYDROLOGIC DATA, Massachusetts Inst. of Tech., Cambridge. Ralph M. For primary bibliographic entry see Field 7C. W91-02870

### 2B. Precipitation

DROUGHT IN FRANCE IN 1989 (LA SECHER-ESSE DE 1989).

Y. Merillon, and P. Chaperon. Houille Blanche HOBLAB, Vol. 1990, No. 5, p 325-339, 1990. 10 fig, 3 tab. English summary.

Descriptors: \*Drought effects, \*France, \*Precipitation, \*Rainfall index, \*Water resources, Agriculture, Rainfall distribution, Water quality, Water

The French drought of 1989 was comparable to the great droughts of the last half century (in 1946, 1976, 1985 and 1986) which had taken place in the southwest of France. The droughts impact many economic sectors—initially agriculture and power-plants. The droughts also caused: widespread euplants. The droughts also caused, widespread ex-trophication; the dessication of numerous rivers; increased pollution effects; and a general decline in available water resources. However, the distribuavailable water resolutes. Towever, the distribu-tion of drinking water was ensured in most cases. From November 1988 to October 1989, the total precipitation which fell on France was 560 mm or 73% of normal. This value represented an average of 31 meteorological stations and is the lowest reading from the last 32 years (1957 to 1989). The precipitation by region was north 550 mm (85%. reaung from the last 32 years (1957 to 1989). The precipitation by region was: north, 559 mm (85% of normal); northeast, 663 mm (86%); west, 579 mm (74%); central east, 546 mm (69%); southwest, 631 mm (73%); southeast, 384 mm (56%); and Corsica, 434 mm (67%). (King-PTT) W91-02048

FLOODS OF 1987 IN THE GLACIAL BASINS SITUATED IN PENNINE ALPS IN SWITZER-LAND (LES CRUES DE L'ETE 1987 DANS LES BASSINS VERSANTS GLACIAIRES DES ALPS PENNINES).

Grande Dixence Societe Anonyme, Sion (Switzerland).

For primary bibliographic entry see Field 2E. W91-02049

STREAM SEDIMENT LOADING AND RAIN-FALL-A LOOK AT THE ISSUE,

FALL—A LOVA AT HE ISSUE. Economic Research Service, Washington, DC. N. D. Uri, and B. Hyberg. Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 1/2, p 95-104, May 1990. 3 fig, 1 tab, 16 ref.

Descriptors: \*Erosion, \*Rainfall intensity, \*Sediment load, \*Soil erosion, Iowa River, Statistical analysis, Storms, Temporal distribution.

Sediment loadings in a stream measured after an intense storm have frequently led to the conclusion intense storm have frequently led to the conclusion that significant soil erosion is associated only with a few storms, or that they are solely a function of peak storm intensities. The issue of the nature of the relationship between stream loading and storm intensity and whether stream sediment loading can best be explained by storm intensity (rainfall) or whether a more general average rainfall measure is superior was examined. Based on data covering the superior was examined. Based on data covering the years 1947 to 1985 for the Iowa River watershed years 1997 to 1995 for the fowar civer watersianship between stream sediment loading and rainfall is indicated. Moreover, average monthly rainfall better explains sediment loading than do other measures explains sediment loading than do other measures of storm (rainfall) intensity. Finally, when the structural stability of the estimated relationships between stream loading and storm intensity are estimated, the conclusion is that the relationship between stream loading and rainfall is stable over the sample period. (Author's abstract) W91-02086

SCHEME FOR PARAMETERIZING ICE-CLOUD WATER CONTENT IN GENERAL CIR-CULATION MODELS.

National Center for Atmospheric Research, Boulder. CO. For primary bibliographic entry see Field 2C. W91-02118

PHYSICS OF SUPERCOOLING OF THIN WATER SKINS COVERING GYRATING HAIL-

STONES Toronto Univ. (Ontario). Dept. of Physic For primary bibliographic entry see Field 2C. W91-02119

PARAMETERIZATION OF THE ACCRETION PROCESS BETWEEN DIFFERENT PRECIPITATION ELEMENTS.

eorological Research Inst., Yatabe (Japan). H. Mizuno

Journal of the Meteorological Society of Japan JMSJAU, Vol. 68, No. 3, p 395-398, June 1990. 2 fig, 26 ref.

Descriptors: \*Accretion, \*Clouds, \*Mathematical Descriptors: Accretion, Accretion rate, Aggrega-tion, Atmospheric physics, Mathematical equa-tions, Mathematical models, Parameterization, Par-

Accretion processes in simultaneous different pre-cipitation elements with their related aggregation process play important roles in precipitation for-mation. These processes produce a large mass transfer between precipitation particles and a broadening of the size distribution. In prior cloud broadening of the size distribution. In prior cloud models, a detailed evaluation of the parameterization of the accretion rate has been lacking. An exact accretion rate was obtained by analytically solving an accretion equation without any arbitrary assumptions. It was shown that the accretion rate used previously had a shortcoming, especially in the cases where two different particles become close in mass-weighted mean fall velocity. As an improvement, a more accurate and simpler parameterization for the accretion rate was recogning. meterization for the accretion rate was proposed based on the exact accretion rate. It was demonstrated that this parameterization was valid for various conditions of the accretion process. (MacKeen-PTT)

W91-02120

RANGE PROFILING OF THE RAIN RATE BY AN AIRBORNE WEATHER RADAR.

AN AIRBORNE WEATHER RADAR.
National Aeronautics and Space Administration,
Greenbelt, MD. Goddard Space Flight Center.
R. Meneghini, and K. Nakamura.
Remote Sensing of the Environment RSEEA7,
Vol. 31, No. 3, p 193-209, March 1990. 10 fig, 20

Descriptors: \*Radar, \*Rain, \*Remote sensing, \*Weather, Airborne weather radar, Attenuation, Dual-wavelength radar, Liquid water content, Mathematical analysis, Rainfall rate.

One of the quantities of interest in a spaceborne weather radar is the rain rate or liquid water content as a function of height. In the presence of attenuation, however, the reconstruction of the profile is possible with usual methods only if the rain rate is uniform or if the relationships between the radar measurables and the rain characteristics are well known. Even with a dual-wavelength radar, estimates of attenuation between adjacent range gates tend to be noisy. A class of methods that are based on a measure of path attenuation which is used to constrain the Hitschfeld-Bordan solution was investigated. Methods of this type have been investigated for lidar, radar, and combined radar-radiometer applications; their functions can be interpreted as allocating the attenuation in proportion to the strength of the measured reflectivity. Four estimates of rain rate were described tivity. Four estimates of rain rate were described and tested using data from a dual-wavelength air-borne radar at 10 GHz and 35 GHz. When attenunoorne radar at 10 OH2 and 35 OH2. When attendation was significant, the estimates were generally more accurate than those without attenuation correction. This suggests that such methods can be used to extend the effective dynamic range of the radar to higher rain rates. Comparisons between the estimates also provide some diagnostic capability for the detection of radar calibration errors. Instabilities in the estimates can occur, however, in cases of low signal to noise ratios and in situations where partially melted hydrometeors contribute to the attenuation. (Author's abstract) W91-02128

SEPTIC TANK AND AGRICULTURAL NON-POINT SOURCE POLLUTION WITHIN A RURAL WATERSHED.

Texas Christian Univ., Fort Worth. Environmental

Sciences Program.
For primary bibliographic entry see Field 5B.
W91-02177

DEVELOPMENT OF THEORETICAL HY-DROLOGY IN WEST AFRICA (DEVELOPPE-MENT DE L'HYDROLOGIE THEORIQUE EN AFRIQUE DE L'OUEST).

Universite Nationale du Benin, Cotonou. Dept. de Mathematique

For primary bibliographic entry see Field 2A. W91-02289

GENERAL CHARACTERISTICS OF SURFACE GENERAL CHARACTERISTICS OF SURFACE
HYDROLOGY IN ARID AND SEMI-ARID
AREAS OF AFRICA AND THEIR CONSEQUENCES FOR DEVELOPMENT (CARACTERES GENERAUX DE L'HYDROLOGIE SUPERFÍCIELLE DES ZONES ARIDES ET SEMIARIDES EN AFRIQUE: LEURS CONSEQUENCES SUR LES ETUDES DES INGEN-

Institut Français de Recherche Scientifique pour le Developpement en Cooperation, Paris. Service

For primary bibliographic entry see Field 2E. W91-02290

FRACTAL APPROACH TO SPATIAL VARIA-BILITY OF WEST AFRICAN RAINFALL EVENTS (APPROCHE FRACTALE DE LA VARIABILITE SPATIALE DES EPISODES PLUVIEUX DE L'AFRIQUE DE L'OUEST).

### Precipitation—Group 2B

(France).
P. Hubert, and J. P. Carbonnel.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 181-190, 5 fig, 2 tab, 11 ref. English

Descriptors: \*Arid lands, \*Fractals, \*Mathematical models, \*Meteorology, \*Model studies, \*Rainfall distribution, \*West Africa, Albedo, Burkina Faso, Network design, Random processes, Spatial distri-

The main characteristic of West African rainfall is its great variability in time and space. This variability is difficult to study and to explain. As the influence of topography is admitted and that of albedo unconfirmed, this variability is often considalbedo unconfirmed, this variability is often considered as a random process. During the rainy season of 1986, a field experiment in Burkina Faso (100 rain gauges spread over 10,000 sq km) permitted the study of the spatial variability of rainfall events by fractal geometry. A downpour observed on June 12-13, 1986 in the region was subjected to an in-depth study using fractal techniques. This permitted an evaluation of the influence of the geometric structure of the measuring network on the preception of the phenomenon under study. The perception of the phenomenon under study. The technique also permitted the recognition and quantification of certain structural elements of the pre-cipitation field, especially its anisotropy. (Rochester-PTT) W91-02301

ANALYSIS OF NON-STATIONARITY OF WEST AFRICAN RAINFALL AND HYDROLO-GICAL SERIES (ANALYSE DE LA NON STA-TIONNARITE DES SERIES PLUVIOMETRI-QUES ET HYDROLOGIQUES D'AFRIQUE DE QUEST, Paris-6 Univ. (France). Dept. de Geologie Dyna-

mique. J. P. Carbonnel, and P. Hubert.

J. P. Carbonnel, and P. Hubert. IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 191-201, 4 fig, 26 ref. English sum-

Descriptors: \*Arid lands, \*Meteorology, \*Rainfall distribution, \*Statistical analysis, \*West Africa, Climates, Frequency distribution, Time series anal-

The Lee and Heghinian statistical procedure was employed to demonstrate the non-stationarity of the West African hydrometeorological series. This non-stationarity of series led to the development of non-stationarity of series led to the development of an original segmentation procedure. Since the beginning of the century the climatic evolution has experienced shifts of stationarity that are synchronous in the whole West African series. The following sequences are distinguishable: before 1906, 1907-1921, 1922-1936, 1937-1949, 1950-1968, and from 1969 to the present. The last shift, in 1968, seems a major event with the general fall in pluvionetric heights. The length of these sequences varies from 13 to 20 yr and they are not cyclic. These results yield a climatic evolution with successive stages on a general downward trend toward more and more extensive aridity. Furthermore, these results challenge the hydrological toward more and more extensive aristly. Furtner-more, these results challenge the hydrological standards and limit, in particular, the use of the notion of climatic means and 'normals' used to describe the years of low and abundant rainfall. (See also W91-02288) (Author's abstract) W91-02302

ELECTRONICS AND INFORMATICS FOR THE ACQUISITION OF HYDROMETEORO-LOGICAL DATA: A GREAT TOOL FOR WATER RESOURCE MANAGEMENT IN THE SAHEL (ELECTRONIQUE ET INFORMATI-QUE POUR L'ACQUISITION DES DONNEES HYDROMETEOROLOGIQUES, UN OUTIL PRODIGIEUX POUR LA GESTION DES RESSOURCES EN EAU DANS LE SAHEL).

Laboratoire General de Recherches, Brussels (Bel-

gium). For primary bibliographic entry see Field 7B. W91-02303

USE OF A DISTRIBUTED MODEL OF A SMALL SAVANNAH CATCHMENT (BOORO-BOROTOU, IVORY COAST) UTILISATION D'UN MODELE DISTRIBUE SUR UN PETIT BASSIN VERSANT DE SAVANE (BOORO-BOROTAUL COSTE PULGUIEF)

BASSIN VERSANI DE 35.7 (1).
BOROTOU, COTE D'IVOIRE).
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Montp Centre de Montpellier. For primary bibliographic entry see Field 2A. W91-02310

UTILIZATION OF THE LAW OF GAPS FOR THE DESCRIPTION OF THE PLUVIOMETRIC REGIME (L'UTILISATION DE LA LOI DES FUITES POUR LA DESCRIPTION DES RE-GIMES PLUVIOMETRIQUES).

GIMES PLUVIOMETRIQUES).
Institut Francais de Recherche Scientifique pour le
Developpement en Cooperation, Niamey (Niger).
Mission ORSTOM au Niger.
L. Le Barbe, G. Ale, and L. Seguis.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of
Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 686-700, 6 fig, 3 ref. English summary.

Descriptors: \*Rainfall distribution, \*Risk assessment, \*Semiarid lands, \*Statistical analysis, Agriculture, Drought, France, Hydrologic mapping, Mapping, Prediction, Temporal distribution.

Information on the risks from variation in the Information on the risks from variation in the rainfall distribution in time is indispensable for establishing the agricultural calendar. Risk definition also serves to determine which crop varieties should be cultivated. If a long dry period is expected during the usual rainy season, resistant plants should be preferred. If the risk is small, one could select plants with a growth cycle corresponding to this duration. The classical solution has been to the statement of the control this duration. The classical solution has been to determine empirically the distribution of pluviometric totals within short time spans (10-day or 5day intervals). Among the problems with this method are its laboriousness and the need to work with short intervals where the errors may be great and the results cannot be mapped easily. The use of the law of cares permit solutions, to the problem. the law of gaps permits solutions to the problem without these difficulties. The law of gaps is simple without these directives. The law of gaps is simple because there are only two parameters: (1) distribution of time spans between two heavy rainfalls and (2) the amount of heavy rain. After the monthly adjustments, one can deduct the distribution of totals for periods shorter than I month and for the time separating two successive rainfalls. The results consume the successive rainfalls are the few that the sub-according to the successive rainfalls. time separating two successive rainfalls. The re-sults can be mapped and interpolation is feasible. It is possible to make a synthesis of all the pluviomet-ric information from 24 maps with monthly values of each of the parameters of the law. Examples are given of the use of the method at sites in France, including mapping of the results. (See also W91-02288) (Author's abstract) W91-02345

CLIMATE AND CLIMATIC RESOURCES OF

RESERVOIRS.
Limnologicheskii Inst., Irkutsk (USSR).
For primary bibliographic entry see Field 2H.
W91-02373

LONG-TERM TRENDS IN THE SESTON CON-TENT OF A SHALLOW EUTROPHIC LAKE AND SOME RELATIONS TO CLIMATIC ELE-

Institute of Geography and Geoecology, Berlin (German D.R.). Dept. of Hydrology. For primary bibliographic entry see Field 2H. W91-02374

USE OF CLUSTER ANALYSIS TO DEFINE PERIODS OF SIMILAR METEOROLOGY AND

PRECIPITATION CHEMISTRY IN EASTERN NORTH AMERICA: PART I. TRANSPORT PATTERNS.

Michigan Univ., Ann Arbor. Dept. of Atmospher-ic, Oceanic and Space Sciences. For primary bibliographic entry see Field 5B.
W91-02409

USE OF CLUSTER ANALYSIS TO DEFINE PERIODS OF SIMILAR METEOROLOGY AND PRECIPITATION CHEMISTRY IN EASTERN NORTH AMERICA: PART II. PRECIPITATION PATTERNS AND POLLUTION DEPOSITION. Michigan Univ., Ann Arbor. Dept. of Atmospheric, Oceanic and Space Sciences.

For primary bibliographic entry see Field 5B. W01-02410

HYDROLOGICAL ASPECTS OF THE DEVEL-OPMENT AND RAPID DECAY OF THE 1989

Institute of Hydrology, Wallingford (England). T. Marsh, and R. Monkhouse. Weather WTHRAL, Vol. 45, No. 8, p 290-299, August 1990. 3 fig, 4 tab, 11 ref.

Descriptors: "Climatology, "Drought, "Great Britain, "Groundwater recharge, "Hydrologic aspects, "Hydrology, "Precipitation excess, "Runoff, "Weather, Evaporation, Groundwater level, Hydrologic budget, Local precipitation, Precipitation, Rainfall, Soil water, Water resources.

In all but a few of Great Britain's eastern districts the persistent and widespread rainfall over a 10-week period beginning in mid-December 1989 served to terminate, in dramatic fashion, a sustained drought which by the late autumn had constituted a significant threat to water resources. The notable recent variations in water resources nie notatoie recent variations in water resources with particular emphasis on the extraordinary transformation in hydrological conditions were ex-amined over the 1989/1990 winter. The transfor-mation reached a climax in February when unprecedented rates of river runoff and aquifer recharge were recorded over large areas. Exceptionally wet were recorded over large areas. Exceptionally wet spells have succeeded sustained dry periods in Britain on a number of occasions, notably following the droughts of 1959, 1976, and 1984. When, as in the last two cases, the drought broke at the end of the summer, the hydrological effectiveness of the heavy rainfall was, initially, reduced by high the neavy rainfail was, initially, reduced by high soil moisture deficits and continuing evaporative losses. The singular nature of the water resources recovery in February 1990 owes as much to the insignificance of these factors throughout most of Britain as the abundant rainfall itself. A very dry Britain as the abundant rainfall itself. A very dry winter, followed by an exceptionally wet one in 1989/90 resulted in monthly runoff totals and a rise and fall of groundwater levels that extended the range of recorded variations in a number of regions. Both winters were also notably mild. In water resources terms this implied an increase in evaporation losses throughout the winter-especially if the climate becomes windier-partly counteracting the benefit that a trend towards, or cluster-ing of, wetter winters would confer. The challenge for climatologists and hydrologists is to determine whether the exceptional conditions recently experienced represent the extreme range of normal variability or are indications of a trend towards less familiar climatic territory. (Mertz-PTT)

PRECIPITATION FLUCTUATION OVER SEMIARID REGIONS IN NORTHERN CHINA AND THE RELATIONSHIP WITH EL NINO/ SOUTHERN OSCILLATION.

Atmospheric and Environmental Research, Inc., Cambridge, MA.

W. Wang, and K. Li. Journal of Climate JLCLEL, Vol. 3, No. 17, p 769-783, July 1990. 9 fig. 4 tab, 30 ref. US DOE Grant No. DE-FG02-86-ER60422.

Descriptors: \*China, \*Climatic changes, \*Climatology, \*Descrification, \*El Nino/Southern Oscillation, \*Meteorological data, \*Meteorology, \*Precipitation, \*Rainfall, \*Semiarid climates, \*Weather

### **Group 2B—Precipitation**

patterns, Atmosphere-ocean interactions, Climates, Correlation analysis, Meteorological data collec-

Many observational studies in recent years suggest that interannual variations in rainfall at low latitudes, sometimes even at middle and high latitudes, are related to the El Nino (EN) and Southern Oscillation (SO) events in the tropics. The interaction between atmosphere and ocean caused by tion between atmosphere and ocean caused by such exchange will have a profound effect on the global climate. In recent years the semiarid region of northern China, which has total annual precipitation between 200 and 500 mm, has shown signs of severe descrification. In this study, the 1951-86 monthly precipitation measurements in this region were used to study their fluctuations and relationships with the El Nino/Southern Oscillation (ENSO). Three main features were identified as a result of the study: (1) a 2-3 year quasi-periodic fluctuation, (2) a tendency for rainfall deficiency for the whole region during ENSO years, and (3) a significant correlation between the precipitation fluctuations in the southern part of this region and significant correlation between the precipitation fluctuations in the southern part of this region and Southern Oscillation index, with the former lagging the latter by 2-5 months. These features are also evident from analysis of the proxy data during the last hundred years. (Korn-PTT) W91-02446

FREQUENCY-RELATED TEMPORALLY AND SPATIALLY VARIED RAINFALL.

Army Engineer District, Fort Worth, TX.
G. R. Perry, and K. L. Shafer.
Journal of Hydraulic Engineering (ASCE)
JHEND8, Vol. 116, No. 10, p 1215-1231, October 1990. 11 fig, 1 tab, 11 ref.

Descriptors: \*Design storms, \*Flood discharge, \*Model studies, \*Rainfall, \*Rainfall distribution, \*Rainfall-runoff relationships, \*Storm runoff, Catchment areas, Drainage patterns, Flood control, Spatial distribution, Temporal distribution, Texas, Watersheds.

A frequency-related design storm with spatial and temporal variation was derived from basic statistical properties. An analysis was performed to determine the impact of the spatially varied (proposed) rainfall pattern on a watershed on Tenmile Creek in Dallas County, Texas. The results of the experiment were as follows: (1) If a large subbasin is suddenly encountered, a peak for that subbasin may produce a secondary area of critical storm centers; (2) The critical storm center path will consider with locations along the stream asth. (1) temporal variation was derived from basic statisticoincide with locations along the stream path; (3) Compared to a spatially uniform rainfall model, a spatially varied synthetic rainfall model is less effi-cient in the total volume of rainfall delivered to a drainage basin and more efficient in placing the volume of rainfall to achieve best effect; (4) Drainvolume of rainfall to achieve best effect; (4) Drainage area discontinuities appear to be an important consideration in modeling a drainage basin, as does the drainage network; and (5) The storm pattern does not affect the critical storm center for small drainage areas, but for larger basins it is presumed that the storm pattern will be a critical element. The frequency-related temporally and spatially varied rainfall analysis produces a graphical illustration of the ideal locations to construct flood control facilities. (MacKeen-PTT) W91-02524

SOME CHARACTERISTICS OF POINT DIS-CHARGE CURRENT DURING TWO PRE-MONSOON SEASON THUNDERSTORMS AT

Indian Inst. of Tropical Meteorology, Poona. G. K. Manohar, S. S. Kandalgaonkar, and S. M. Sholapurkar.

Current Science CUSCAM, Vol. 59, No. 7, p 367-370, April 10, 1990. 4 tab, 18 ref.

Descriptors: \*Electric currents, \*Meteorology, "Monsoons, "Point discharge current, "Thunder-storms, "Weather data collections, Distribution patterns, Electric fields, Electrical studies, Fre-quency distribution, India.

During the periods of thunderstorms when strong electric fields exist, transfer of negative/positive

charge to the earth through point discharges from surface irregularities takes place. Measurements of point discharge current were made at Pune during two pre-monsoon season thunderstorms of 198 and 1988. The point discharging element consisted of a platinum/10% iridium needle 0.5 mm in diameter and about 2 cm long erected at a height of 14 m above the ground level. Continuous record of m above the ground level. Continuous record of point discharge current was obtained. The monthly distribution of the number of days of thunderstorms in the pre-monsoon months (April, May and June) of 1987 was seen to vary from that of 1988 (0/7, 6/1, and 5/2 days, respectively), though the total number of seasonal thunderstorm days on both occasions were equal. The daily features of point discharge current on the days of thunderstorm during 1987 and 1988 are as follows. The seasonal positive charge received by the earth was +31.51 mC in 1987 and +16.14 mC in 1988. Similarly the seasonal negative charge received was -19.09 mC in 1987 and -21.79 mC in 1988. Normalized frequency distribution of spells and Normalized frequency distribution of spells and diurnal time duration of point discharge current and the values of charge received by the earth are also presented. Results suggest that thunderstorms in May through June contributed for excess posi-tive charge rather than negative charge, and thuntive charge rather than negative charge, and thun-derstorms in April contributed for excess negative charge. In 1987 longer durations of positive cur-rent prevailed than those of negative and in 1988 the reverse was noticed. During 1987 an apprecia-ble duration of point discharge current persisted even beyond mid-night hours, which was unlike that in 1988. However, since the above results are based on limited observations, these inferences should be taken with sufficient reservation and detailed verification is necessary from future works. (VerNooy-PTT) W91-02553

CHARACTERIZATION OF YEAR-ROUND SENSITIVITY OF CALIFORNIA'S MONTANE LAKES TO ACIDIC DEPOSITION. California Univ., Santa Barbara. Marine Science

For primary bibliographic entry see Field 5B. W91-02619

INFLUENCE OF ACID ATMOSPHERIC INPUTS ON SURFACE WATER CHEMISTRY AND MINERAL FLUXES IN A DECLINING SPRUCE STAND WITHIN A SMALL CATCHMENT (VOSGES MASSIF, FRANCE). Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Sedimentologie et de Geochimie de la Surface.

For primary bibliographic entry see Field 5B. W91-02741

STORMFLOW HYDROCHEMISTRY OF A SMALL WELSH UPLAND CATCHMENT.
Institute of Terrestrial Ecology, Bangor (Wales). Bangor Research Station.
For primary bibliographic entry see Field 2K. W91-02748

DOPPLER-RADAR ANALYSIS OF A LOW-PRECIPITATION SEVERE STORM.

H. B. Bluestein, and G. R. Woodall.

Monthly Weather Review MWREAB, Vol. 118, No. 8, p 1640-1664, August 1990. 26 fig, 61 ref, append.

Descriptors: \*Convective precipitation, \*Meteorology, \*Radar, \*Remote sensing, \*Storms, Hail, Meteorological data, Oklahoma, Rain, Weather patterns, Wind.

The structure and evolution of a convective storm that formed along the dryline in Oklahoma on 26 April 1984 and developed into a supercell was studied in detail. Dual-Doppler wind analyses, analyses of surface-mesonetwork and instrumented-tower data, storm-intercept photographs, analy-ses of raingage data from a dense network, and storm reports were used. The storm exhibited the following low-precipitation (LP) characteristics: the absence of any strong, evaporatively cooled, storm-scale downdraft near the surface; a paucity of rain reaching the ground; large hail; long-lived rotating updrafts; and a strong, relatively small in areal extent, unicellular radar echo. The storm areat extent, unicellular radar echo. In estorm split, and its right-moving member developed into an isolated, high-precipitation supercell. It is suggested that the region under cloud base was associated with strong radar echo caused by widely spaced, large water droplets and halistones. Separate cyclonically and anticyclonically rotating upderfer, were found on the southern and northern rate cyclonically and anticyclonically rotating up-drafts were found on the southern and northern flanks of the storm, respectively. The high correla-tion between vorticity and vertical motion is cir-cumstantial evidence that they are dynamically related. The storm split as the updrafts on the northern and southern flanks of the LP storm developed precipitation cores, and each propagat-ed away from the original echo. (Author's ab-stract) W91-02760

TROPICAL SQUALL LINE OBSERVED DURING THE COPT 81 EXPERIMENT IN WEST AFRICA. PART III: HEAT AND MOIS-TURE BUDGETS

Centre National de Recherches Meteorologiques,

M. Chong, and D. Hauser. Monthly Weather Review MWREAB, Vol. 118, No. 8, p 1696-1706, August 1990. 10 fig, 32 ref.

Descriptors: \*Atmospheric physics, \*Atmospheric water, \*Heat budget, \*Meteorology, \*Moisture content, \*Squalls, \*Storms, \*Tropical regions, \*West Africa, Condensation, Convection, Cooling, Drying, Evaporation, Heat flow, Melting, Meteorological data collection, Radar, Remote sensing.

The role of moist convective processes in the heat and moisture budgets of a June 1981 tropical squall line, observed in West Africa during the cooperative experiment COPT 81 (COnvection Profonde Tropicale), was investigated using Doppler radar observations. Condensation and evaporation, through the release of latent heat, were the dominant terms in the total apparent heating profile although the melting process was also important. The total apparent moisture sink was also dominated by condensation and evaporation. However, the eddy moisture flux had an important influence on the vertical structure. The total apparent heat source was marked by a deeper layer of cooling, while the total apparent moisture sink had a single peak observed in the middle troposphere. The convective-scale heating profile indicated a net coolwhile the total apparent moisture sink had a single peak observed in the middle troposphere. The convective-scale heating profile indicated a net cooling in the lower troposphere, mainly due to the evaporation of precipitation. This cooling could be explained by a deep subsaturated layer where convective precipitation was evaporated. The convective-region moisture sink profile exhibited drying through the full depth of the troposphere, but with a peak at middle levels. It was found that this relatively high position of the drying peak resulted from the specific contribution of the eddy moisture transport in the convective region, which was concentrated in the low-to-middle troposphere and which tended to raise the drying peak due to condensation in convective updrafts. From this particular impact of convective dedies the occurrence of a double-peaked structure in the total apparent moisture sink is proposed. It was also found that ambient air entering the system at midlevels strongly modified the vertical exchange from convective updrafts by limiting it to the lower part of the troposphere. (Author's abstract) W91-02761

BIOSPHERE AND CLIMATE.

W91-02803

Akademiya Nauk SSSR, Leningrad. Inst. for Lake Research. For primary bibliographic entry see Field 2A.

SENSITIVITY OF THE SURFACE HYDROLOGY TO THE COMPLEXITY OF THE LAND-SURFACE PARAMETERIZATION SCHEME EMPLOYED.

Macquarie Univ., North Ryde (Australia). School of Earth Science

### Precipitation—Group 2B

For primary bibliographic entry see Field 7C. W91-02804

GEOGRAPHIC DISTRIBUTION AND CLIMATIC VARIATION OF THE PLUVIAL REGIMES IN BAJA CALIFORNIA SUR, MEXICO (DISTRIBUCION GEOGRAFICA Y VARIABILIDAD CLIMATICA DE LOS REGIMENES PLUVIOMETRICOS EN BAJA CALIFORNIA SUR,

Centro de Investigaciones Biologicas de Baja Cali-

Centro de Investigaciones Biologicas de Baja Cali-fornia Sur, La Paz (Mexico). C. A. SalinasZavala, A. LeyvaContreras, D. LluchBelda, and E. Diaz-Rivera. Atmosfera ATMSEF, Vol. 3, No. 3, p 217-237, July 1990. 7 fig, 5 tab, 23 ref. (English summary).

Descriptors: \*Baja California, \*Climatic zones, \*Climatology, \*Precipitation mapping, \*Weather data collections, Mexico, Physiographic provinces, Rainfall distribution, Weather patterns.

Rainfall distribution, Weather patterns.

Annual pluvial precipitation patterns obtained from 57 weather stations in the southern part of the Baja California Peninsula, Mexico, during more than 20 years were analyzed. Three distinct periods are readily recognizable from the annual mean pattern: Period I corresponding to the dry season from March to June; Period II corresponding to the rainy season from November to February. A regionalization was obtained from the rainy regime based on the relative weight of both rainy periods, marked along the mean physiographic climatological zonal features, that in general terms correspond to the climatic zonation obtained by several authors based on different data sets. Notwithstanding the geographic distribution in accord with the mean physiographical and climatic index is proposed which, seems to indicate that the tropical and temperate influences go beyond the regions of predominance. The variability of some casual phenomena associated with the zonal weather tendencies also were analyzed by means of an original interpretation of harmonic analysis (Author's abstract) analyzed by means of an original interpretation of harmonic analysis. (Author's abstract)
W91-02805

ACID DEPOSITIONS, SUMMER DROUGHTS, FOREST DECLINE; DEVELOPMENT OF THE

FOREST DECLINE: DEVELOPMENT OF THE NITROUS ACID HYPOTHESIS.

Association pour la Prevention de la Pollution Atmospherique, Bordeaux (France).

For primary bibliographic entry see Field 5C.

W91-02828

LIQUID WATER CONTENT AND PRECIPITA-TION CHARACTERISTICS OF STRATIFORM CLOUDS AS INFERRED FROM SATELLITE MICROWAVE MEASUREMENTS.

Pennsylvania State Univ., University Park. Dept.

of Meteorology.
J. A. Curry, C. D. Ardeel, and L. Ti Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 10, p 16,659-16,671, Sep-tember 20, 1990. 13 fig, 3 tab, 55 ref.

Descriptors: \*Cloud liquid water, \*Meteorology, \*Microwaves, \*Precipitation, \*Remote sensing, \*Satellite technology, Atmospheric water, Cloud physics, Clouds, Data acquisition, Radiometry.

An analysis of the integrated liquid water content and precipitation characteristics of stratiform clouds using data from Nimbus 7 Scanning Multi-channel Microwave Radiometer (SMMR) for Janchannel Microwave Radiometer (SMMR) for January 1979, over the North Atlantic Ocean is presented. Concurrent analysis of the SMMR data with the US Air Force 3-Dimensional Nephanalysis (3DNEPH) allows the interpretation of the SMMR-derived liquid water paths and precipitation characteristics in terms of cloud type, cloud fraction, and cloud height. Combining the initialized analyses from the European Center for Medium Range Weather Forecasting (ECMWF) with the 3DNEPH enables vertical temperature and humidity profiles to be incorporated into the retrievals. The average liquid water paths for middle and low clouds were determined to be 115

and 102 g/sq m, respectively, with a maximum value of 1070 g/sq m. Analysis showed that the clouds were substantially diluted by a combination of precipitation, freezing and entrainment. Analysis of the liquid water path as a function of temperature showed that clouds with average temperatures below 246 K had very little liquid water, and were inferred to be predominantly crystalline. There was little evidence that the cloud liquid water path increases with temperature for cloudiness on a large scale, suggesting that cloud thickness plays the dominant role in determining cloud liquid water path. A total of 8.5% and 4.4% of the total middle and low clouds, respectively, were determined to be raining. Liquid water paths of 350 g/sq m and 55 g/sq m for middle and low clouds, were determined to be average thresholds for the onset of precipitation. Maximum rain rates for these clouds were determined to be 7 mm/h. The autoconversion of cloud water to rain water was determined to occur at a rate of 0.001/s. (Lantz-PTT) W91-02835

# PASSIVE MICROWAVE REMOTE SENSING OF CLOUD LIQUID WATER OVER LAND RE-

Cooperative Inst. for Research in the Atmosphere,

Fort Collins, CO.
A. S. Jones, and T. H. Vonder Harr. Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 10, p 16,673-16,683, Sep-tember 20, 1990. 5 fig, 5 tab, 40 ref. ARO Grant No. DAAL03-86-G-0190.

Descriptors: \*Cloud liquid water, \*Meteorology, \*Microwaves, \*Remote sensing, Atmospheric water, Data acquisition, Radiation, Radiometry, Satellite technology, Temperature.

Techniques for cloud liquid water retrieval over lechniques for cloud inquid water retrieval over land are developed using data from the Special Sensory Microwave/Imagery 85.5 GHz (3.5 mm) channels. To minimize the effect of surface emittance variability on the calculations, the surface emittance was estimated with the aid of surface skin temperature retrievals from the Visible Infraskin temperature retrievals from the Visible Infrared Spin Scan Radiometer in geosynchronous
robit. The high sensitivity of the 85.5 GHz channels to cloud liquid water allows for the estimation
of integrated cloud liquid water based on the
microwave brightness temperature depression
caused by attenuation and emission of microwave
radiation at the colder ambient temperature of the
cloud. The method assumes non-scattering radioacrive processes are dominant; therefore, only nonprecipitating cloud liquid water is considered. Integrated cloud liquid water retrievals show good
qualitative agreement with other available data
sources. Numerical error sensitivity analysis
showed integrated cloud liquid water error estimates of 0.05-0.50 kg/sq m depending on the contrast of cloud over background. (Author's abstract)
W91-02836

### PRECIPITATION CHEMISTRY IN CENTRAL

AMAZONIA. Florida State Univ., Tallahassee. Dept. of Oceanography. M. O. Andreae, R. W. Talbot, H. Berresheim, and

M. O. Andreae, R. W. Andrea, T. M. C. M. Beccher.
Journal of Geophysical Research (D) Atmospheres
JGRDE3, Vol. 95, No. 10, p 16,987-16,999, September 20, 1990. 12 fig, 4 tab, 57 ref. NASA
Tropospheric Chemistry Program Grant No.

Descriptors: \*Acid rain, \*Amazon River Basin, \*Chemistry of precipitation, \*Path of pollutants, \*Water pollution sources, Aerosols, Chlorides, Fluctuations, Nitrates, Organic acids, Potassium, Precipitation, Seasonal variation, Sodium, Statisti-cal analysis, Sulfates, Tropical regions.

Rain samples from three sites in central Amazon were collected over a period of 6 weeks during the 1987 wet season and analyzed for ionic species and 1967 wet season and analyzed for forme species and dissolved organic carbon. A continuous record of precipitation chemistry and amount was obtained at two of these sites, which were free from local or regional pollution, for a period of over one month.

The volume weighted mean concentrations of most species were about a factor of 5 lower during the wet season. Only Na, K, and Cl2 showed similar concentrations in both seasons. When the seasonal difference in rainfall amount is taken into consideration, the deposition fluxes are only slightconsideration, the deposition fluxes are only slightly lower for most species during the wet season
than during the dry season, again with the exception of Cl2, Na, and K. Na and Cl2 are present in
the same ratio as in sea salt; rapid advection of air
masses of marine origin to the central Amazon
Basin during the wet season may be responsible for
the observed higher deposition flux of these species. Statistical analysis suggests that sulfate is, to a
large extent, of marine (sea salt and biogenic)
origin, but that long range transport of combustion large extent, of marine (sea salt and biogenic) origin, but that long range transport of combustion derived aerosols also makes a significant contribution to sulfate and nitrate in Amazonian rain. Organic acid concentrations in rain were responsible for a large fraction of the observed precipitation acidity; their concentration was strongly influenced by gas/liquid interactions. (Author's abstract) W91-02840

# RAINFALL AND SURFACE KINEMATIC CON-DITIONS OVER CENTRAL AMAZONIA DURING ABLE 2B.

James Madison Univ., Harrisonburg, VA. Dept. of Geology and Geography. S. Greco, R. Swap, M. Garstang, S. Ulanski, and

M. Shphain. Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 10, p 17,001-17,014, Sep-tember 20, 1990. 16 fig, 5 tab, 32 ref. NSF Grant No. ATM85-18826.

Descriptors: \*Amazon River Basin, \*Chemistry of precipitation, \*Climatology, \*Data interpretation, \*Hydrologic budget, \*Meteorology, \*Rainfall, \*Satellite technology, Acetates, Acid rain, Aerosols, Formates, Meteorological data collection, Pyruvates, Rainfall intensity, Remote sensing, Suffates Teorolal rasings. fates. Tropical regions

Meteorological and chemical data collected during the wet season Amazon Boundary Layer Experiment near Manaus, Brazil, were used to investigate the rainfall, rainfall systems, and surface kinematics of the south central Amazon basin wet season. Analysis of the Geostationary Operational Environmental Satellite (GOES-West) imagery indicated that, based on location of initial development, there are three main types of convective systems which influence a mesoscale network near Manaus. Coastal Occurring Systems (COS) are mesoscale to synoptic scale sized systems of generally linear orientation which form along the northern coast of Brazil and propagate across the Amazon Basin. Meteorological and chemical data collected during Brazil and propagate across the Amazon Basin. The Basin Occurring Systems (BOS) form in the basin east and north of Manaus and also propagate oward the network. Locally Occurring Sys toward the network. Locally Occurring Systems (LOS) form in and around the mesoscale network and rarely are larger than 1000 cu km. Composites of hourly rainfall totals and satellite derived cloud cover show that rainfall and cloudiness associated with COS occurred in the network between 1000 and 1400 UT. Little rain or cloud cover was seen before 1600 UT during days influenced by LOS. Chemical analysis of the rain water delivered by these systems also shows significant differences in the concentrations of formate, acetate, pruyate. these systems also shows significant differences in the concentrations of formate, acctate, pyruvate, sulfate, and hydrogen ion. In addition, aerosol concentrations measured near Manaus indicate large influxes of aerosols (Na, Cl, and Si) into central Amazonia after the passage of BOS and COS. During April 11-20, BOS occurred on 8 days and produced 98% of the rainfall. Eight COS occurred during April 21 to May 3 and accounted for 89% of the rainfall. The final part of the experiment, May 4-14, was influenced solely by LOS. Harmonic analysis of surface divergence during this period exhibits a peak at 24 hours. This peak, representing the diurnal heating cycle, does not exist earlier in the experiment when BOS and COS are more frequent. (Author's abstract) W91-02841

ESTIMATES OF DAILY RAINFALL OVER THE AMAZON BASIN.

### Group 2B—Precipitation

Wisconsin Univ.-Madison. Space Science and Engineering Center. D. W. Martin, B. Goodman, T. J. Schmit, and E

C. Cutrim.

C. Cuttim.

Journal of Geophysical Research (D) Atmospheres

JGRDE3, Vol. 95, No. 10, p 17,043-17,050, September 20, 1990. 6 fig. 5 tab, 20 ref. NSF Grant

No. ATM-8703966.

Descriptors: \*Amazon River Basin, \*Data acquisi-tion, \*Rainfall, \*Remote sensing, Mapping, Maps, Meteorology, Rain gages, Rainfall distribution, Satellite technology, Surveys, Temperature, Tropi-

Five geostationary satellite rain estimation techniques were tested over Amazonia. Individually, the techniques explained 1/4 to 1/3 of the variance of daily gage rainfall. Based on large part on cost, one technique which involves a nonlinear relation one technique winch involves a nonlinear relation in temperature, was selected to provide a mapping of daily Amazonia rainfall between May 6 and 12, 1987. Accumulated over seven days, rainfall by this technique averaged 40 mm. It varied from zero in the southeast to more than 150 mm in the in the southeast to more than 150 mm in the northwest. To the southwest the predominantly convective pattern of the rain image was overlaid by a streakness, implying some baroclinic influence. In maps combining gage observations with satellite estimates, rainfall varied significantly from day to day. Only over the largest scale did a trend emerge-a tendency for rain to withdraw from south to north. (Author's abstract)

INCORPORATING HILLSLOPE EFFECTS
INTO THE GEOMORPHOLOGIC INSTANTA-NEOUS UNIT HYDROGRAPH. CH2M/Hill, Reston, VA.

For primary bibliographic entry see Field 2E. W91-02868

CLIMATIC INFLUENCES ON STREAMFLOW VARIABILITY: A COMPARISON BETWEEN SOUTHEASTERN AUSTRALIA AND SOUTHEASTERN UNITED STATES OF AMERICA. Melbourne Univ., Parkville (Australia). Dept. of

Melodurie Univ., Parkville (Australia). Dept. of Civil and Agricultural Engineering. I. Kuhnel, T. A. McMahon, B. L. Finlayson, A. Haines, and P. H. Whetton. Water Resources Research WRERAQ, Vol. 26, No. 10, p 2483-2496, October 1990. 9 fig, 3 tab, 42

Descriptors: \*Australia, \*Climates, \*Climatology, \*Rainfall, \*Rainfall-runoff relationships, \*Runoff, \*Stream discharge, \*Streamflow forecasting, At-mospheric circulation, Comparison studies, Flow rates, Seasonal distribution, Southern oscillation.

Differences in runoff and rainfall variability between southeastern Australia and southeastern United States have been examined, using various standard techniques such as principal component and spectral analyses, and examination of the quick and base flow components of runoff. The higher runoff variability in Australia can be explained, in part, by the large-scale circulation and rainfall partierns associated with the Southern Oscillation which are unlike those in the southeastern United States. Whereas the Southern Oscillation signal is easily detectable in the southeast Australian rainfall and runoff data, it is, with the exception of several small areas, absent in the southeastern United States data. In the case of this particular compari-son, the differences in runoff variability between the two selected regions were found to be largest in winter and spring months and smallest in summer. Among the continents, Australia shows the strongest impact of the Southern Oscillation, and the different rainfall and runoff variability in the two specific regions is likely to be similar when comparing Australia with any other part of the world. (Author's abstract) W91-02877

PERIODIC-STOCHASTIC MODELING OF SEPARATION OF PRECIPITATION INTO RAINFALL AND SNOWFALL. Colorado State Univ., Fort Collins. Dept. of Civil

Engineering.
V. Yevjevich, and N. B. Harmancioglu.
Water Resources Research WRERAQ, Vol. 26,
No. 10, p 2613-2623, October 1990, 17 fig, 1 tab, 23
ref. National Science Foundation Grant CEE-

8405289/8541631

Descriptors: \*Model studies, \*Precipitation, \*Rainfall, \*Runoff, \*Snowfall, \*Stochastic models, Distribution, Fourier analysis, Markov process, Mathematical models, Probability distribution, Statisti-

Modelers must separate precipitation into rainfall and snowfall because the two processes have significant differences as input to runoff. The purpose of the present study is to model this separation, provided that available data permit the coding of observed precipitation as rainfall, snowfall, and/or mixed rainfall-snowfall. Modeling of precipitation is realized by a simple approach such as the periodic-stochastic Markov chain description of occurrence and nonoccurrence of time interval precipitation. The exponential probability distribution ne-stochastic Markov Chain description of Occurrence and nonoccurrence of time interval precipitation. The exponential probability distribution based function, with periodic parameters, are is for modeling the nonzero values of precipitation. The generated series are then separated into rainfall and snowfall components by means of the rainfall-precipitation ratio. This ratio is modeled as a periodic-stochastic process in the range zero to one. The bounded (0,1)-beta distribution function is selected as the appropriate distribution function is selected the ratio when it can also assume values between the ratio when it can also assume values between fitted well by one-harmonic and two-harmonic Fourier functions. Two sets of daily precipitation series, each ten years long, are used to demonstrate the results of modeling daily precipitation and daily rainfall-precipitation ratio: the Bansanson precipitation gauging station in the Durance River basin, France (as a point process), and the W-watershed area, near Danville, Vermont (as a daily average areal precipitation process). The investigawatersned area, near Danvine, vermont (as a daily average areal precipitation process). The investiga-tion shows the feasibility of modeling the separa-tion when observed precipitation is coded for rain-fall, snowfall, or mixed rainfall-snowfall. (Brunone-W91-02886

COMPUTER-CONTROLLED AUTOMATED RAIN SAMPLER (CCARS) FOR RAINFALL MEASUREMENT AND SEQUENTIAL SAM-PLING.

Battelle Pacific Northwest Labs., Richland, WA. For primary bibliographic entry see Field 7B. W91-02914

### 2C. Snow, Ice, and Frost

REMOTE SENSING APPLIED TO GLACIER SUPERVISION IN THE FRENCH ALPS (YEARS 1986, 1987 AND 1988)(TELEDETEC-TION APPLIQUEE AU SUIVI DES GLACIERS DES ALPES FRANCAISES (ANNEES 1986, 1987 ET 1988)).

Grenoble-1 Univ. (France). Lab. de la Montagne Alpine.

For primary bibliographic entry see Field 7B. W91-02051

GLACIAL MASS BALANCE DETERMINATION IN THE ACCUMULATION ZONE BY IN SITU MEASUREMENTS OF TCHERNOBYL RADIO-ACTIVITY (DETERMINATION DU BILAN GLACIAIRE EN ZONE D'ACCUMULATION PAR MESURE IN SITU DE LA RADIOACTI-VITE DUE A TCHERNOBYL).

Laboratoire de Glaciologie et Geophysique de l'Environnement, Saint-Martin d'Heres (France). J. F. Pinglot, and M. Pourchet. Houille Blanche HOBLAB, Vol. 1990, No. 5, p 359-361, 1990. 3 fig, 7 ref. English summary.

Descriptors: \*Chernobyl, \*Data acquisition, \*Fallout, \*Glacier mass balance, \*New snow, \*Radioactivity, \*Tracers, Glaciers, Snow accumulation, Snow sampling.

Glacial mass balance determination in the accumu-Glacial mass balance determination in the accumulation zone is accomplished by the determination of the water equivalent of the fresh snow cover. Radioactive fallout due to the Chernobyl accident on April 26th, 1986, has already been identified in Northern hemisphere glaciers, where it has provided a new reference level. An in situ gamma ray spectrometer was developed in order to detect the radiation from Chernobyl directly in the field. Therefore the depth of the Chernobyl layer can be determined. (Author's abstract)

SCHEME FOR PARAMETERIZING ICE-CLOUD WATER CONTENT IN GENERAL CIR-CULATION MODELS.

National Center for Atmospheric Research, Boulder. CO.

Journal of the Atmospheric Sciences JAHSAK, Vol. 47, No. 15, p. 1865-1877, August 1990. 8 fig, 3 tab, 39 ref, 2 append. NASA Contract L98100B, NASA Grant NAG-1056, NSF Grant ATM-85

Descriptors: \*Clouds, \*Data interpretation, \*Ice clouds, \*Model studies, \*Moisture content, Climatic changes, Cloud liquid water, Cloud physics, Mathematical models, Meteorological data, Meteorology, Optical properties, Three-dimensional model.

The optical properties of ice clouds are a primary issue for climate and climate change. Evaluating these optical properties in three-dimensional models for studying climate will require a method to calculate the ice water content of such clouds.

A procedure is developed to parameterize ice water content as a function of large-scale meteorological characteristics for use in circulation models, in which the ice water content is not calculated by means of a three-dimensional prognostic equation for condensed water. The technique identifies large-scale flows in which ice clouds exist and calculates their ice water content by reconstruct-ing the trajectory associated with cloud formation. As the cloud forms, its ice content changes both by As the cloud forms, its ice content changes both by deposition of ice from water vapor and by ice removal by sedimentation. The sedimentation process is found to significantly modify the ice water content expected from deposition alone. Ice water contents predicted by the parameterization were compared with aircraft observations collection with the content of the were compared with aircraft observations collect-ed in the middle latitudes and the tropics, and show reasonable agreement over four orders of magnitude of ice and water content. A parameteri-zation for the sublimation of ice crystals settling into ice-subsaturated environments has also been developed. (Author's abstract)

PHYSICS OF SUPERCOOLING OF THIN WATER SKINS COVERING GYRATING HAIL-

Toronto Univ. (Ontario). Dept. of Physics.

R. List. Journal of the Atmospheric Sciences JAHSAK, Vol. 47, No. 15, p 1919-1925, August 1990. 7 fig, 10

Descriptors: \*Atmospheric physics, \*Freezing, \*Hail, \*Precipitation, \*Supercooling, Air-water interfaces, Heat transfer, Ice formation, Ice-water interfaces, Physical analysis.

Liquid water skins on spongy deposits of hailstones that grow while gyrating in a wind tunnel environ-ment, have been routinely observed to be super-cooled at the water skin-air interface to as low as cooled at the water skin-air interface to as low as -5 C. The average water skin thickness (up to 1 mm) in the main growth region was calculated on the basis of the molecular conduction of the latent heat of freezing from the spongy substrate at the base of the water skin to its surface. This heat transfer is gradient-driven and relates directly to the speed of ice accretion on the hailstone. Extrapolation of an equation for the ice growth speed in supercooled bulk water suggested a supercooling of the ice-water interface on the order of 4.3 C. The physical picture which emerged, was that

### **Evaporation and Transpiration—Group 2D**

of an ice sponge from which a fragile dendrite mesh grows into the water skin with a very homo-geneous front, and an advance speed that is con-trolled by the diffusion of heat (heat conduction) aroneu by the diffusion of heat (heat conduction) away from the ice front. Combining all results, it can be categorically stated that all surface points of growing hailstones have temperatures below the freezing point of water. (Author's abstract) W91-02119

FIELD FROST HEAVE MEASUREMENT AND PREDICTION DURING PERIODS OF SEA-

Agriculture Canada, Ottawa (Ontario). Land Re-

Agriculture Canada, Ottawa (Ontario). Land Resource Research Centre.
H. N. Hayhoe, and D. Balchin.
Canadian Geotechnical Journal CGJOAH, Vol.
27, No. 3, p 393-397, June 1990. 8 fig. 1 tab, 12 ref.

Descriptors: \*Data acquisition, \*Electrical equipment, \*Freezing, \*Frost heaving, \*Instrumentation, \*Thermocouples, Canada, Cultivation, Loam, Soil properties, Soil temperature, Temperature

Frost heave measurements were taken over two Frost heave measurements were taken over two winter seasons on a clay loam soil located near Ottawa, Canada. Heaving was measured using linear displacement transducers attached to a metal frame that was anchored in the soil below the depth of frost penetration. The output of the displacement transducer was recorded hourly using a microcomputer based data logger. The system functioned reliably and the observed data compared well with published measurements. Soil temperature was recorded simultaneously using thermocouples placed at various depths up to 1 m. Time-domain reflectometry was used to measure mocouples placed at various depths up to 1 m. Time-domain reflectometry was used to measure the unfrozen water content at approximately two week intervals. The study shows that soil temperature measurements can be used to estimate the temperature gradient at the freezing front for determining the cumulative frost heave, as suggested by the Konrad-Morgenstern theory of ice segregation processes. The results also support the observation that tilled soils are more susceptible to heave than undisturbed soils. (Author's abstract) W91-02150

RECONSTRUCTION AND DYNAMICS OF THE LATE WISCONSIN 'ONTARIO' ICE DOME IN THE FINGER LAKES REGION, NEW YORK.

Maryland Univ., College Park. Dept. of Geology.

R. W. Ridky, and R. A. Bindschadler.

Geological Society of America Bulletin BUGMAF, Vol. 102, No. 8, p 1055-1064, August 1990. 5 fig, 2 tab, 67 ref.

Descriptors: \*Finger Lakes, \*Glacial drift, \*Glacier mass balance, \*Glaciers, \*Glaciology, \*Ice thickness, \*New York, Drumlins, Glacial sediments, Ice pressure, Mathematical models, Shear

Distribution of drumlins on the Ontario Lowlands and the northern Appalachian Plateau of New York State are utilized in a glaciological model that estimates thicknesses of the Late Wisconsin Ice Sheet along five glacial flowlines over the central section of the Finger Lakes. Dynamics of the model are based upon a force balance approach that incorporates variable width of a flowband, bedslope, radius of curvature, and center of outflow location. Drumlin axes along five hydrostatic isograms were projected northward. Points of axes convergence define the center of outflow in the eastern Ontario Basin. Flowlines along the axial trace of the major Seneca and Cayuga Troughs and bordering interfluves were constructed southward to the Valley Heads Moraine System. Calculation of flowline geometry for any assumed basal shear stress requires neither information on ice temperature nor the flow law of ice. Ice thicknesses for each flow line were calculated for vari-Distribution of drumlins on the Ontario Lowlands temperature nor the flow law of ice. Ice thick-nesses for each flow line were calculated for vari-ous basal shear stresses. Ice thicknesses at 1 bar range from a minimum of 1,932 m for the Seneca Trough flowline to a maximum of 2,093 m at the Keuka-Seneca interfluve. Simulating ice recession, a series of ice-marginal, terminal positions were plotted for a basal shear stress of 1 bar. These

predicted terminal positions agree well with loca-tions of mapped moraine deposits. These probable values of basal shear stress support the presence of glacial flow representative of internal deformation rather than basal sliding. This evidence discounts gates from representative of internal deformation rather than basal sliding. This evidence discounts the presence of ice streams and supports the existence of outlet glaciers in the troughs of the Finger Lakes. (Author's abstract)

FAST-FLOWING OUTLET GLACIERS ON SVALBARD ICE CAPS.

Scott Polar Research Inst., Cambridge (England). J. A. Dowdeswell, and R. L. Collin.

Geology GLGYBA, Vol. 18, No. 8, p 778-781, August 1990. 5 fig, 18 ref. United Kingdom Natural Environment Grant GR3/4663.

Descriptors: \*Glacier balance, \*Glacier mass balance, \*Glaciers, \*Glaciohydrology, \*Svalbard, Aerial photography, Arctic zone, Glacial streams, Remote sensing, Satellite technology.

Fast-flowing outlet glaciers and ice streams provide a mechanism for the rapid discharge of mass from ice sheets, implying that their dynamic behavior through time is of particular significance to the stability of the parent ice mass. Four well-defined outlet glaciers are present on the 2510 sq km ice cap of Vestfonna in Nordaustlandet, Sval-bard. Airborne radio echo sounding and aerial photograph and satellite image analysis methods have been used to analyze the morphology and dynamics of the ice cap and its component outlet glaciers. The heavily crevassed outlets form linear depressions in the ice cap surface and flow an order of magnitude faster than the ridges of uncrevassed ice between them. Ice flow on the ridges is accounted for by internal deformation alone, accounted for by internal deformation alone, whereas rates of outlet glacier flow require basal whereas rates of outlet glacier flow require basal notion. One outlet has recently switched into and out of a faster mode of flow. Rapid terminal advance, a change from longitudinal compression to tension, and thinning in the upper basin indicate surge behavior. Observed outlet glacier discharge is significantly greater than current inputs of mass to the ice cap, indicating that present rates of flow cannot be sustained under the contemporary climate. (Author's abstract) W91-02154

TILL GENESIS AND HYDROGEOLOGICAL PROPERTIES.

Norges Landbrukshoegskole, Aas. For primary bibliographic entry see Field 2F.

EFFECTS OF GLACIAL SURGING ON SEDI-MENTATION IN A MODERN ICE-CONTACT LAKE, ALASKA.

Illinois Univ. at Chicago Circle. Dept. of Geologi-

For primary bibliographic entry see Field 2J. W91-02520

PERIODIC-STOCHASTIC MODELING OF SEPARATION OF PRECIPITATION INTO RAINFALL AND SNOWFALL.

Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W91-02886

GLACIOMARINE SEDIMENTATION IN DIS-RAELI FJIORD, HIGH ARCTIC CANADA. Alberta Univ., Edmonton. Dept. of Geographic entry see Field 2J.

COMPRESSIVE STRENGTH BEHAVIOR OF FINE-GRAINED FROZEN SOILS Calgary Univ. (Alberta). Dept. of Civil Engineer-

For primary bibliographic entry see Field 8D. W91-02940

### 2D. Evaporation and Transpiration

SIMPLIFIED METHOD TO ESTIMATE RE-GIONAL 24-H EVAPOTRANSPIRATION FROM THERMAL INFRARED DATA.

FRUM IHERMAL INFRARED DATA.
Winand Staring Centre for Integrated Land, Soil
and Water Research, Wageningen (Netherlands).
H. A. M. Thunnissen, and G. J. A. Nieuwenhuis.
Remote Sensing of the Environment RSEEA7,
Vol. 31, No. 3, p 211-225, March 1990. 11 fig. 2

Descriptors: \*Data interpretation, \*Evapotranspiration, \*Infrared radiation, \*Mathematical analysis, \*Remote sensing, \*Temperature, Analytical methods, Climates, Crops, Plants, Reflection, Thermal infrared data, Wind velocity.

A thermal infrared image provides information about crop evapotranspiration in a certain area at flight time. A simple method has been developed to convert instantaneous crop temperatures into 24-h evapotranspiration values. For clear days, good results were obtained with a linear relationship between relative 24-h evapotranspiration and the increase in crop temperature around mid-day. The crop temperature is related to the temperature of the crop that is potentially transpiring. For the typical flight days to detect crop stress conditions, the empirical coefficient B(r) appeared to be almost insensitive to variations in air temperature, almost insensitive to variations in air temperature, relative humidity, and incoming radiation flux. On the other hand, B(r) was strongly dependent on wind velocity, crop type, and crop height. Information about crop type and crop height land be derived from reflection images. The wind velocity can be obtained from a nearby meteorological station. Overall, the method appears to be suited to the automatic mapping of 24-h evapotranspiration values with the aid of digital reflection and thermal infrared images. However, amplication of the infrared images. However, application of the method requires plots with full soil overage. (Author's abstract) W91-02129

WATER VAPOR TRANSPORT THROUGH A FLAIL-CHOPPED CORN RESIDUE. Wisconsin Univ., Madison. Dept. of Soil Science. For primary bibliographic entry see Field 3F. W91-02130

NEW METHOD TO DETERMINE REGIONAL EVAPOTRANSPIRATION.

EVAPOTRANSPIRATION.
Weizmann Inst. of Science, Rehovoth (Israel).
Dept. of Isotope Research.
M. Margaritz, A. Kaufman, M. Paul, E. Boaretto,
and G. Hollos.
Water Resources Research WRERAQ, Vol. 26,
No. 8, p 1759-1762, August 1990. 3 fig, 2 tab, 14

Descriptors: \*Climatic changes, \*Evapotranspira-tion, \*Global warming, \*Greenhouse effect, \*Hy-drologic budget, \*Hydrologic cycle, \*Model stud-ies, Chlorides, Geochemistry, Jordan River, Pre-cipitation, Radioisotopes.

The climatic changes which are expected to result from man-made atmospheric pollution will undoubtedly affect the natural hydrologic cycle. Models which will address the effect of man-made pollution on recharge rates to groundwater must take into account changes in the rate of evaporative loss (EL). Any geochemical model for the estimation of EL would be based upon a comparison between the concentration of some hydrophilic ion in a sample of resource water to the concentraion in a sample of resource water to the concentraion in a sample of resource water to the concentra-tion of that ion in precipitation. A method has been developed comparing the chloride concentration and the ratio of Cl36 to total chloride of a given water body to those of precipitation to determine the fraction of the original precipitation which was lost by evapotranspiration before it reached that water body. This method was applied to 11 water sources in the upper Jordan River basin, and the evapotranspirative loss was generally found to be evapotranspirative loss was generally found to be in the range 40-90%. This method, which is much simpler than the other methods for determining regional evapotranspiration, will enable us to mon-

### Group 2D-Evaporation and Transpiration

itor the changes in the hydrological cycle which are expected to result from the greenhouse effect. ert-PTT)

WATER LOSSES IN THE NILE BASIN. International Inst. for Hydraulic and Environmental Engineering, Delft (Netherlands).
For primary bibliographic entry see Field 2A.

EVAPORATION FROM FREE WATER SUR-FACES IN THE SUDANO-SAHELIAN CLI-MATE (L'EVAPORATION DES NAPPES D'EAU LIBRE EN CLIMAT SOUDANO-SAHE-LIEN).

Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Montpellier. Centre de Montpellier.

B. Pouvaud.

B. Fouyaud.

IN: The State-of-the-Art of Hydrology and Hydrogoology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 169-180, 11 ref. English summary.

Descriptors: \*Africa, \*Arid lands, \*Evaporation, \*Hydrologic budget, \*Sahel, \*Sudan, Climates, Estimating equations, Penman formula, Water resources management.

In the Sudano-Sahelian zone of Africa, evapora-tion is the most important parameter of the water balance. How to plan the management of water is problematical when this parameter is inadequately estimated, even when it exceeds precipitation by 2estimated, even when it exceeds precipitation by 2-10 times. Similarly, agricultural consumption is not sufficiently known, making irrigation calculations difficult. To evaluate the evaporation, the engineer must rely on data derived from nearby sites. Ques-tions will remain concerning (1) whether there is a water management plan from which one could draw a hydrological balance; (2) whether there are draw a hydrological balance; (2) whether there are climatological references stations, whether they are equipped with evaporation pans and, if so, of what type; and (3) whether all parameters are known for application of the Penman formula. Area scales (size of the water body) and time scales (time intervals in which evaporation has been de-termined) are reliable determinants as well. All formulas are not comparable if area and time scales are not identical. Methods described and compared here include: hydrologic balance, evaporation pan methods, the energetic approach, and evaporation from free water surfaces based on a global aerody-namic transfers. (See also W91-02288) (Rochester-PTT W91-02300

HYDROLOGIC REGIME UNDER NATURAL HYDROLOGIC REGIME UNDER NATURAL CLIMATIC CONDITIONS IN THE LATERITIC SOIL OF BURKINA FASO (REGIME HYDRI-QUE EN CONDITIONS CLIMATIQUES NATURELLES D'UN SOL LATERITIQUE DU BURKINA FASO). Ecole Inter-Etats d'Ingenieurs de l'Equipement Rural, Ouagadougou (Burkina Faso). For primary bibliographic entry see Field 2G. W91-02317

WATER TRANSFER IN POROUS NON-SATURATED ROCK AND AQUIFER RECHARGE IN THE SUDANO-SAHELIAN CLIMATE (TRANSFERT D'EAU EN MILIEU POREUX NON SATURE RECHARGE DES NAPPES EN CLIMAT SOUDANO-SAHELIEN).

Ecole Inter-Etats d'Ingenieurs de l'Equipement Rural, Ouagadougou (Burkina Faso). For primary bibliographic entry see Field 2F. W91-02319

ESTIMATES OF EVAPOTRANSPIRATION WITH A ONE- AND TWO-LAYER MODEL OF HEAT TRANSFER OVER PARTIAL CANOPY

Agricultural Research Service, Beltsville, MD. Hydrology Lab.

W. P. Kustas Journal of Applied Meteorology JAMOAX, Vol. 29, No. 8, p 704-715, August 1990. 7 fig, 3 tab, 55 29, No. 8, p ref, append.

Descriptors: \*Canopy, \*Evapotranspiration, \*Heat transfer, \*Model studies, \*Remote sensing, Cotton, Eddy correlation, Heat flux, Temperature, Weath-

One of the applications of remotely sensed surface temperature is to determine the latent heat flux or evapotranspiration from field to regional scales. Surface-air temperature differences have been suc-cessfully applied over uniform terrain with nearly full, actively transpiring vegetative cover; howev-er, serious discrepancies between estimated and measured evapotranspiration have been observed when there is partial canopy cover. In an attempt to improve the estimates of heat flux and as a result to improve the estimates of heat flux and as a result compute more accurate values of evapotranspira-tion over partial canopy cover, one-layer and two-layer resistance models were developed to account for some of the factors causing the poor agreement tor some or the factors classing the poor agreement between computed and measured evapotranspira-tion. The utility of these two approaches for esti-mating evapotranspiration at the field scale is tested with remotely sensed and micrometerological data collected in an arid environment from a furrowed cotton field with 20% cover and a dry soil surface. The estimates of latent heat flux were soil surface. The estimates of latent heat flux were compared with values measured using eddy corre-lation and energy balance methods. It was found that the one-layer model generally performed better than the two-layer model under these conditions; but only when using a bluff-body correction to the resistance based on a conceptual model of to the resistance based on a conceptual model of heat and water vapor transfer at the surface taking place by molecular diffusion into Kolmogorov-scale eddies. The empirical adjustment to the surface resistance with the one-layer approach assumed to be applicable for a fairly wide range of conditions was found to be inappropriate. This result is attributed to the significant size of the furrows relative to the height of the vegetation. Furthermore, a sensitivity analysis showed that the Furthermore, a sensitivity analysis showed that the one-layer model with the empirical adjustment for the resistance was significantly affected by the changes in the surface roughness, whereas the physically based bluff-body correction was relaphysically based bluff-body correction was relatively insensitive to these variations. For the two-layer model, a large change in the input variable for computing soil evaporation had a relatively small impact on the computed fluxes while a significant change in the leaf area index appeared to amplify the deviations between measured and modeled latent heat flux-values. (Author's abstract) W91-02408

REMOTE SENSING APPLICATIONS FOR CONSUMPTIVE USE (EVAPOTRANSPIRA-

For primary bibliographic entry see Field 7B. W91-02594

COMBINED SIMULATION OF CANOPY RE-FLECTANCE AND THERMAL RESPONSE FOR ESTIMATING EVAPOTRANSPIRATION. Maryland Univ., College Park. Remote Sensing

A. S. Hope, D. E. Petzold, S. N. Goward, and R. M. Ragan.

M. Ragan. Ilb: Remote Sensing Applications for Consumptive Use (Evapotranspiration). Papers Presented at 21st Annual AWRA Conference and Symposium, August 11-16, 1985. Tucson, Arizona. AWRA Monograph Series No. 6, (1985). p 1-11, 6 fig, 20

Descriptors: \*Evapotranspiration, \*Remote sensing, \*Simulation analysis, Albedo, Canopy, Energy, Evaporation, Model studies, Radiation, Reflectance, Soil-water-plant relationships, Stress, Transpiration, Vegetation.

The SAIL canopy reflectance model was incorporated into the TERGRA model to simulate water and energy flows in the soil-plant-atmosphere system. The reflectance model was structured to calculate canopy albedo throughout the simulation period of TERGRA and to determine spectral

reflectances at a specified time during the day. Spectral vegetation indices were then calculated from the reflectances, and related to the evapotranspiration and thermal response of the canopy. Stomatal resistances were calculated from these PAR values and integrated to give the minimum canopy values and integrated to give the minimum canopy resistance. Actual canopy resistances were obtained by considering environmental stresses, modeled by TERGRA, such as leaf water potential and leaf temperature. Using data from a soybean canopy, canopy evapotranspiration and temperatures were simulated for a range of leaf area index tures were simulated for a range of leaf area index values and compared with the corresponding spectral indices of green vegetation. Results indicated that the normalized difference spectral index has an inverse linear relationship with canopy temperature, concurring with results obtained from satelite observations. The possibility of using a spectral vegetation index and thermal observations together to parametize surface moisture availability for evaportanspiration is considered. (See also W91-02594) (Author's abstract) W91-02595

ESTIMATING AREAL EVAPOTRANSPIRA-TION BY COMBINING REMOTE AND GROUND-BASED DATA.

Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.

R D Jackson

R. D. Jackson.

IN: Remote Sensing Applications for Consumptive Use (Evapotranspiration). Papers Presented at 21st Annual AWRA Conference and Symposium, August 11-16, 1985, Tucson, Arizona. AWRA Monograph Series No. 6, (1985). p 13-23, 7 fig, 21

Descriptors: \*Evapotranspiration, \*Remote sensing, Albedo, Data acquisition, Radiation, Reflectance, Solar radiation, Spatial distribution, Temperature.

Evaluating transpiration on a field-by-field basis over relatively large areas can be accomplished by combining remotely sensed data with ground based measurements. Reflected solar radiation and surface temperatures vary spatially, but can be determined by multispectral measurements. Incoming solar and sky radiation can be considered to be uniformly spatially distributed (for cloudless skies). Thus, their measurement at one location can be uniformly spatially distributed (for cloudless skies). Thus, their measurement at one location can be extrapolated over an extended area. Combining remote and ground based data allows the spatial distribution of net radiation and evapotranspiration (ET) to be mapped. The evapotranspiration alculation also requires that air temperature and wind speed be areally extrapolated. The spatial variability of these two parameters may be the limiting factor in mapping evapotranspiration over large areas. Data are presented that show a comparison of remote values with traditionally measured of remote values with traditionally measured values of reflected solar radiation, net radiation, and evapotranspiration. The areal extent over which reliable ET estimates can be made depends on the distance that the ground measured param-eters can be extrapolated. Calculations indicate that the extrapolation of air temperature and wind-speed may be the limiting factors. (See also W91-02594) (Lantz-PTT)

ESTIMATES OF CONSUMPTIVE USE AND EVAPOTRANSPIRATION IN PALO VERDE VALLEY, CALIFORNIA, 1981 AND 1983. Geological Survey, Tucson, AZ. Water Resources

L. H. Raymond, and S. J. Owen-Joyce

In: Remote Sensing Applications for Consumptive Use (Evapotranspiration). Papers Presented at 21st Annual AWRA Conference and Symposium, August 11-16, 1985, Tucson, Arizona. AWRA Monograph Series No. 6, (1985). p 25-34, 6 tab, 20 ref.

Descriptors: \*Consumptive use, \*Data interpreta-tion, \*Evapotranspiration, \*Palo Verde Valley, \*Remote sensing, Colorado River, Crops, Data acquisition, Hydrologic budget, Landsat, Satellite technology, Vegetation.

### Streamflow and Runoff-Group 2E

Consumptive use was calculated in 1981 and 1983 using a water budget, and evapotranspiration was calculated using vegetative types and acreage determined from Landsat digital-image analysis and two sets of water-use rates. Evapotranspiration ranged from 73-85% of consumptive use in 1981 and 91-105% in 1983. Crop acreage and flow in the Colorado River in 1981 were more representative of normal conditions in the valley than were those in 1983, but rainfall in 1981 was 68% below average. Evapotranspiration calculated using vegetation acreage is dependent on water use rates that were developed in the field for crops and phreatophytes in other areas. These water-use rates may need to be estimated on a yearly basis, rather than using an average value for each vegetation type, because of climatic changes from year to year. The 1981 data more closely represent the results to be expected in comparing consumptive use and evapotranspiration in other years than does the 1983 data. (See also W91-02594) Consumptive use was calculated in 1981 and 1983

SIMULATION OF LAKE EVAPORATION WITH APPLICATION TO MODELING LAKE LEVEL VARIATIONS OF HARNEY-MALHEUR LAKE, OREGON. Geological Survey, Denver, CO. For primary bibliographic entry see Field 2H. W91-02885

### 2E. Streamflow and Runoff

DROUGHT IN FRANCE IN 1989 (LA SECHER-For primary bibliographic entry see Field 2B. W91-02048

FLOODS OF 1987 IN THE GLACIAL BASINS SITUATED IN PENNINE ALPS IN SWITZER-LAND (LES CRUES DE L'ETE 1987 DANS LES BASSINS VERSANTS GLACIAIRES DES ALPS

Grande Dixence Societe Anonyme, Sion (Switzer-

Jand). Y. Rey, and G. Dayer. Houille Blanche HOBLAB, Vol. 1990, No. 5, p 349-353, 1990. 1 fig. 2 tab, 6 ref. English summary.

Descriptors: \*Alps, \*Floods, \*Glaciers, \*Switzer-land, Rhone River, Snowmelt.

Increased rainfall in the Pennine Alps of Switzer-land during 1987 added to the swollen output of glacial meltwater during July and August, and, for more than 24 hours, some basins drained an average of 1,400 to 1,500 L/s/sq km. The flow in some basins was estimated at 4,500 to 5,000 L/s/sq km. There was a 20% increase in the level of the Rhone in Valais, Switzerland. The precipitation in some of these localities had periodicities estimated to be in the range of 80 to 100 years. The basins covered include Gornera, the Alps of Statel, Vallon de Ferpecie, Hauf d'Arolla, Gouillie Borgne, and Val des Dix. (King-PTT) W91-02049

CHARACTERISTICS OF COARSE WOOD DEBRIS FOR SEVERAL COASTAL STREAMS OF SOUTHEAST ALASKA, USA. Oregon State Univ., Corvallis. Forest Research

For primary bibliographic entry see Field 4C. W01\_02063

MEASURING EPILITHIC BACTERIAL PRODUCTION IN STREAMS. Guelph Univ. (Ontario). Dept. of Zoology. For primary bibliographic entry see Field 2H.

SLOPE, ASPECT, AND PHOSPHOGYPSUM EFFECTS ON RUNOFF AND EROSION. Soil Erosion Research Station, Natanya (Israel). M. Agassi, I. Shainberg, and J. Morin. Soil Science Society of America Journal SSSJD4,

Vol. 54, No. 4, p 1102-1106, July/August 1990. 4 fig, 2 tab, 11 ref.

Descriptors: \*Erosion, \*Runoff, \*Slope stability, \*Slopes, \*Soil amendments, \*Soil erosion, \*Soil stabilization, Erosion rates, Field tests, Israel, Phosphogypsum, Rain gages, Rainfall, Rainfallrunoff relationships.

The effect of slope, aspect (windward vs. leeward), and phosphogypsum (PG) application on rain amount, runoff, and erosion from a Grumusol soil (Typic Chromoxerert in Israel) was measured in small field plots (1 by 1.5 m) exposed to natural rainstorms. The amount of effective rain on the slopes, as measured with small rain gauges with orifices in a plane parallel to the slope, increased slightly on the windward aspect as slope increased to approximately 58% and decreased thereafter. On the leeward aspect, the amount of effective rain dropped steadily to half of the meteorological rain at a slope of 100%. The amount of runoff was not affected by slope on the windward aspect but decreased. PG releases electrolytes into the percolating and runoff water, prevents dispersion of the increased. PG releases electrolytes into the perco-lating and runoff water, prevents dispersion of the particles at the surface, stabilizes the soil structure and reduced soil erosion. PG applied at 5 Mg/ha reduced runoff to about 25% of that in the control and reduced soil loss to 1 to 3% of that in the control. The dramatic effect of PG on erosion increased with increased slope steepness. (Author's abstract) W91-02139

STREAMFLOW DATA AND SURFACE-WATER RESOURCE ASSESSMENT - A QUANTITATIVE DEMONSTRATION OF NEED FOR ADEQUATE INVESTMENT IN DATA COLLECTION IN DEVELOPING COUNTRIES.

Imperial Coll of Science and Technology London Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering. For primary bibliographic entry see Field 7A. W91-02141

SIMILARITY AND LENGTH SCALE FOR SPA-TIALLY VARIED OVERLAND FLOW. Colorado State Univ., Fort Collins. Dept. of Civil

Colorad State Univ., For Collins, Dept. of Civil Engineering. P. Y. Julien, and G. E. Moglen. Water Resources Research WRERAQ, Vol. 26, No. 8, p 1810-1832, August 1990. 10 fig. 2 tab, 35 ref. U. S. Army Research Grant ARO/DAAL 03-86-K-0175.

Descriptors: "Overland flow, "Precipitation, "Rainfall distribution, "Rainfall intensity, "Rainfall-runoff relationships, "Surface runoff, Finite element method, Infiltration, Roughness, Runoff, Scale factors, Spatial variability, Statistical methods, Storm runoff, Topography.

The influence of the spatial variability of rainfall precipitation, infiltration, surface roughness and surface topography on surface runoff characteristics has been widely recognized in hydrology. One-dimensional finite element models enable physically based investigations of overland flow generated under spatially varied surface slope, width, roughness, and excess rainfall intensity. Simulated results of 8400 dimensionless hydrographs under spatially varied input parameters indicate that runoff discharge variations depend primarily on the ratio of rainfall duration t(r) to the time to equilibrium t(e). Peak discharge distributions change drastically as the dimensionless rainfall duration t(r)/t(e) approaches unity. Similarity conditions exist for all four parameters regardless of whether the spatial variability is correlated or uncorrelated. A length scale function of not only the spatially averaged values of surface parameters but also depending upon rainstorm duration and intensity delineates similarity conditions for spatially varied surface runoff. For surface runoff lengths much shorter than this length scale, the rainfall-runoff relationship becomes nearly independent of the spatial variability in hydrologic parameters. Conversely, for surface runoff lengths exceeding the length scale, the rainfall-runoff relationship is sensitive to spatial variability. This length scale can serve as a basis for the determination of grid sizes in hydrologic models. (Author's abstract) The influence of the spatial variability of rainfall

W91-02189

ANALYSIS OF WATER SURFACE AND FLOW DISTRIBUTION FOR THE DESIGN FLOOD AT A PROPOSED HIGHWAY CROSSING OF THE SABINE RIVER NEAR TATUM, TEXAS. Geological Survey, Austin, TX. Water Resources

Div.
J. J. Gilbert, and D. R. Myers.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4231, 1989. 36p, 18 fig, 5 tab, 11 ref.

Descriptors: \*Design floods, \*Design flow, \*Finite element method, \*Flow models, \*Highway relocation, \*Model studies, \*Sabine River, \*Texas, Flood plains, Floods, Model testing, Simulation, Tatum.

The hydraulic effects of the proposed Texas Highway 43 crossing of the Sabine River were determined using a two-dimensional finite-element surface-water flow model (FESWMS). In the planning of the crossing by the Texas State Highway ning of the crossing by the Texas State Highway Department, accurate approximations of apportionment of flow among the openings and velocities within the openings were of concern. The model was used to simulate flow in the river floodplain system for the proposed crossing design, an alternate crossing design, and for the natural conditions. The alternate design more closely represents the existing bridge widths. Preliminary one-dimensional computations were used as an aid in establishing the boundary conditions for the two-dimensional analysis. The simulations show that, among other things, a proposed lengthening of the dimensional analysis. The simulations show that, among other things, a proposed lengthening of the right overflow bridge is not beneficial. The alternate design is one that does not include the proposed lengthening of the right overflow bridge or the proposed construction of a new embankment at the existing main channel opening. The results of the two-dimensional simulation of the proposed design indicate some differences in the apportionment of flow among the openings when compared to the one-dimensional proposed crossing computations. Simulations of the alternate crossing design resulted in water-surface altitudes which are slighttations. Simulations of the alternate crossing design resulted in water-surface altitudes which are slightly lower than the proposed design. The alternate design would require less modification to the existing embankment. Velocities computed at the bridge abutments using the two-dimensional model were within the design specifications of the Texas State Department of Highways and Public Transportation. (USGS) W91-02226

SURFACE-WATER HYDROLOGY AND SALINITY OF THE ANCLOTE RIVER ESTUARY, FLORIDA.

Geological Survey, Tampa, FL. Water Resources

M. Fernandez. M. Pernandez. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4046, Feb 1990. 44p, 25 fig, 6 tab, 12 ref. Project no. FL-

Descriptors: \*Anclote River, \*Estuaries, \*Florida, \*Saline-freshwater interfaces, Regression analysis.

Direct measurements of streamflow, tides, and sa-linity in the Anclote River Estuary, Florida were made during the period January 1984 through May 1986; historical streamflow was compared to that measured during the study; the influence of well-field pumpage on streamflow was evaluated; and regression relations between salinity, tide, and avregression relations between salinity, tide, and average daily streamflow were developed. Mean monthly streamflow during the study period generally were lower than the corresponding long-term monthly averages yet representative of flows that typically enter the estuary. The influence of pumpage from individual well fields in or near the basin on streamflow was not statistically significant; the influence of total well-field pumpage, however, was significant at the 5% level. The upstream daily location of 0.44+, 5.0-, 10-, and 18-parts-per-thousand (ppt) salinity was quantified using multiple regression techniques. Streamflow

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used in the analysis ranged from 2.3 to 263 cu ft/sec, and high tides ranged from 0.25 ft below to 2.76 ft above sea level. Vertical salinity profiles indicated partially to well-mixed conditions throughout the estuary during the study period. Results of the regression analyses show that streamflow has a large effect on the location of the salinity) as well as water having a salinity of 5.0 ppt. The location of water having salinities greater than 5.0 ppt is affected increasingly by tide, with a corresponding decrease in effect by streamflow. (USGS) correspond (USGS) W91-02229

POTENTIAL HAZARDS FROM FLOOD-FLOWS IN GRAPEVINE CANYON, DEATH VALLEY NATIONAL MONUMENT, CALIFOR-NIA AND NEVADA.
Geological Survey, Sacramento, CA. Water Re-

Geological Survey, Sacration of Sources Div.

J. C. Bowers.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Water-Resources Investigations Report 89-4063, 1990. 19p, 2 fig, 3 tab, 7 ref, 1 plate.

Descriptors: \*California, \*Death Valley National Monument, \*Flash floods, \*Flood flow, \*Flood frequency, \*Flood recurrence interval, \*Nevada, Arid-zone hydrology, Channel erosion, Cross-sections, Discharge, Drainage basins, Flood profiles, Grapevine Canyon, Inundation, Mudflows, Regional analysis, Scottys Castle.

Grapevine Canyon is on the western slope of the Grapevine Mountains in the northern part of Death Valley National Monument, California and Nevada. Grapevine Canyon Road covers the entire width of the canyon floor in places and is a frequently traveled route to Scotty's Castle in the canyon. The region is arid and subject to flash flooding because of infrequent but intense convective storms. When these storms occur, normally in the summer, the resulting floods may create a hazard to visitor safety and property. Historical data on rainfall and floodflow in Grapevine Canyon are sparse. Data from studies made for data on rainfall and floodflow in Grapevine Canyon are sparse. Data from studies made for similar areas in the desert mountains of southern California provide the basis for estimating discharges and the corresponding frequency of floods in the study area. Results of this study indicate that high-velocity flows of water and debris, even at shallow depths, may scour and damage Grapevine Canyon Road. When discharge exceeds 4,900 cu fl/sec, expected at a recurrence interval of between 25 and 50 years, the Scotty's Castle access road and bridge may be damaged and the parking lot partly inundated. A flood having a 100-year or greater recurrence interval probably would wash out the bridge and present a hazard to the stable and garage buildings but not to the castle buildings, whose foundations are higher than the predicted maximum flood level. (USGS)

SUMMARY OF BIOLOGICAL INVESTIGA-TIONS RELATING TO SURFACE-WATER QUALITY IN THE KENTUCKY RIVER BASIN, KENTUCKY

Geological Survey, Reston, VA. Water Resources

For primary bibliographic entry see Field 5C. W91-02232

MASS-CONSERVING METHOD OF CHARAC-TERISTICS FOR STREAMFLOW MODELING. Geological Survey, Tacoma, WA. Water Resources Div. W. G. Sikonia.

w. U. SIKOBIA. Available from Books and Open File Report Sec-tion, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-414, 1989. 75p, 11 fig, 1 tab, 14 ref.

Descriptors: \*Computer models, \*Mathematical models, \*Model studies, \*Open-channel flow, \*Streamflow, \*Unsteady flow, Differential equations, Finite element method, Hydrodynamics, Mathematical analysis, Numerical analysis, River

A robust numerical model is presented for the computation of unsteady streamflow on steep river slopes. The one-dimensional model uses the method of characteristics on a specified space-time grid to solve the Saint-Venant equations. An addi-tional continuity equation requirement on each space-time element provides greatly improved con-servation of mass over traditional implementations of the method of characteristics on a fixed grid. of the method of characteristics on a fixed grid. The space-time geometry of the problem is described in a finite element setting. Hermite interpolation of channel parameters is used to avoid numerical difficulties that may occur with steep slopes due to discontinuities in the derivatives of data such as channel top width. Manning's equation for friction slope can be modified by a factor to make the slope more appropriate for steep rivers. The standard Manning's friction slope can also be used, if preferred. The computer model is not restricted to steep slopes, and applies as well to gently sloping streams. Two numerical examples support the mathematical approach and computational algorithm. (USGS) tional algorithm. (USGS) W91-02234

BIBLIOGRAPHY OF U.S. GEOLOGICAL SURVEY REPORTS ON THE WATER RE-SOURCES OF FLORIDA, 1886-1989. Geological Survey, Tallahassee, FL. Water Re-

sources Div. For primary bibliographic entry see Field 10C. W91-02237

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1989, VOLUME 3B: SOUTH-WEST FLORIDA GROUND WATER. Geological Survey, Tampa, FL. Water Resources

For primary bibliographic entry see Field 7C. W91-02240

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1989. Geological Survey, Salt Lake City, UT. Water

Resources Div.
For primary bibliographic entry see Field 7C.
W91-02241

IMPROVED METHODS FOR REGIONAL FLOOD FREQUENCY ANALYSIS. Colorado State Univ., Fort Collins. Dept. of Civil

Engineering.
J. D. Salas, D. C. Boes, D. C. Cunnane, S. Guo, and L. Cadavid.

National Technical Informat

and L. Cadavid.
Available from National Technical Information
Service, Springfield, VA 22161 as PB90-233334/
AS. Price codes: A06 in paper copy, A01 in microfiche. Hydrology and Water Resources Program,
Final Report, March 1990. 113p, 32 fig, 12 tab, 77
ref. 2 append. USGS Contract no. 14-08-0001G1285.

Descriptors: \*Estimating, \*Flood frequency, \*Frequency analysis, \*Prediction, \*Regional floods, Arkansas River Basin, Colorado, Colorado River Basin, Flood data, Illinois, Model studies, Planning, Regional analysis, Rio Grande Basin.

The overall objective of the research has been to ane overan objective of the research has been to develop flood frequency models and estimation methods for prediction of floods at gaged and ungaged watersheds. Several topics were studied under this project including, estimation of Pearson III model, properties and estimation of non-conventional distributions such as mixture models, and regional maximum likelihood estimation (MLE). In addition, amplications to flood data in Cologado. addition, applications to flood data in Colorado and Illinois regions were made. Population moments, moment-ratio diagrams and separation conditions of mixture and two-component product models were studied. New families of mixture of models were studied. New families of mixture of quantile models as well as estimation based on censored MLE for mixture models were devel-oped. Likewise, moment and MLE procedures for estimating the Box-Cox transformation parameter were derived. Results based on simulation experi-ments indicated that regional MLE may be benefi-cial in estimating flood quantiles at a given site as compared to at site estimates or estimates derived

by alternative least square methods, under the as-sumption of a reliable regional parametric struc-ture. However, as the parametric structure be-comes unreliable, the benefits of regional MLE become less apparent. Likewise, in comparing re-gional MLE with generalized least squares meth-ods based on observed flood data, results indicate that both methods perform about the same. (USGS) W91-02243

PREPARATION OF AVERAGE ANNUAL RUNOFF MAP OF THE UNITED STATES,

Geological Survey, Madison, WI. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02247

FLOODS OF FEBRUARY 1989 IN TENNESSEE. Geological Survey, Nashville, TN. Water Resources Div. For primary bibliographic entry see Field 4A. W91-02260

WATER RESOURCES DATA FOR ARKANSAS, WATER YEAR 1989. Geological Survey, Little Rock, AR. Water Re-

For primary bibliographic entry see Field 7C. W91-02261

GENERAL CHARACTERISTICS OF SURFACE GENERAL CHARACTERISTICS OF SURFACE HYDROLOGY IN ARID AND SEMI-ARID AREAS OF AFRICA AND THEIR CONSE-QUENCES FOR DEVELOPMENT (CARAC-TERES GENERAUX DE L'HYDROLOGIE SU-PERFICIELLE DES ZONES ARIDES ET SEMI-ARIDES EN AFRIQUE: LEURS CONSE-QUENCES SUR LES ETUDES DES INGEN-

IEURS).
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Paris. Service Hydrologique.
J. A. Rodier.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 15-34, 7 fig, 2 tab, 38 ref. English summary. summary.

Descriptors: \*Africa, \*Arid lands, \*Flood hydro-graphs, \*Floods, \*Rainfall-runoff relationships, \*Semiarid lands, Climates, Infiltration, Mathematical models, Prediction, Regression analysis, Statis-

Although many hydrological characteristics are the same for all arid zones, tropical Africa presents particular characteristics: well-defined rainy season, simple storm intensity patterns, high temperatures, impervious crust on many soils reducing infiltration, large part of the soil without cultivation, and few and very sparse hydrometric networks. This situation dictates certain approaches to estimating the 10 very flood and mean annual discontinuation. works. In is situation dictates certain approaches to estimating the 10-yr flood and mean annual dis-charge and its distribution for small and relatively small basins. In the absence of network data, pre-cipitation series are used as a statistical basis comcipitation series are used as a statistical basis com-bined with the transformation of precipitation into discharges analyzed in representative basins and transposed for unknown basins. Global models are used for the heterogeneity problems. For the 10-yr flood, the approach is deterministic and uses broadly the unit hydrograph, the flood flow being for most cases surface runoff. The production function often is simple, the storm pattern being energally the same and the precipitation depth by generally the same and the precipitation depth by far the most important factor in runoff depth. In the past, empirical curves have been established giving the runoff coefficient for the 10-yr precipi-tation from the basin area, slope global index, and infiltrability class. For very small basins, these curves (revised in 1986) give the runoff coefficient for daily precipitation from 70 mm and 100 mm depth. A catalog of quantitative infiltrability of soil

surfaces makes the infiltrability classification more surfaces makes the infiltrability classification more reliable. The transfer function corresponds to the unit hydrograph. For the transposition, empirical curves give the rise time, base time, and the peak coefficient in relation to slope area secondary factors using a checklist. The large number of representative basins permits the cautious use of multiple regression. This methodology, which presents some limitations (hydrographic degeneration), will be improved by the use of the catalog and of a checklist of the factors neglected by the regressions. The methodology can be employed for the transposition of statistical distribution of annual runoff depths. (See also W91-02288) (Author's abrunoff depths. (See also W91-02288) (Author's abstract) W91-02290

TOWARDS A REGIONAL WATER RESOURCE STUDY OF ARID AND SEMI-ARID AFRICA. Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 2A. W91-02295

IMPACT OF SOIL SURFACE DETERIORA-TION ON RUNOFF PRODUCTION IN THE ARID AND SEMI-ARID ZONES OF WEST

AFRICA.
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Lome (Togo).
Centre ORSTOM du Togo.
For primary bibliographic entry see Field 4C.
W91-02296

SURFACE FEATURES: ONE OF THE KEY ELEMENTS OF SAHELIAN HYDROLOGY (LES ETATS DE SURFACE: UNE DES CLEFS DE L'HYDROLOGIE SAHELIENNE). DE L'HYDROLLOGIE SAHELLENNE).
Institut Francais de Recherche Scientifique pour le
Developpement en Cooperation, Lome (Togo).
Centre ORSTOM du Togo.
For primary bibliographic entry see Field 2A.
W91-02297

ANALYSIS OF DROUGHT IN ETHIOPIA BASED ON NILE RIVER FLOW RECORDS. Illinois State Water Survey Div., Champaign. For primary bibliographic entry see Field 2A. W91-02299

PREDETERMINATION OF FLOODS IN SMALL SAHELIAN BASINS UNDER 10 SQUARE KILOMETERS (LA PREDETERMINATIONE DES CRUES SUR DES PETITS BASSINS SAHELIENS INFERIEURS A 10 KM2). Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Montpellier. P. Ribstein, and J. A. Rodier. IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 222-232, 11 ref. English summary.

Descriptors: \*Africa, \*Arid lands, \*Flood forecasting, \*Flood peak, \*Floods, \*Sahel, \*Semiarid lands, \*Ungaged streams, Estimating equations, Fictitious basin concept, Infiltration, Rainfall-runoff relationships, Unit hydrographs.

Practical rules were developed for the estimation of peak discharge of the 10-yr flood on ungauged basins under 10 sq km in the Sahel, West Africa. This work was carried out on 29 representative Sahelian catchments. Problems of flood estimation Sahelian catchments. Problems of flood estimation in the Sahel are presented and original aspects of the procedure are pointed out. The estimation of the 10 yr flood uses observed data, the runoff coefficient, and the unit hydrograph parameters. The use of the fictitious basin concept was employed for the survey of the whole variation field of the hydrograph characteristics in relation to four main factors: area, 10-yr rainfall depth, slope, and infiltrability. The method can be employed in conjunction with a questionnaire to take into account possible extreme values of other runoff factors of possible significant influence. (See also W91-02288) (Author's abstract)

W91-02305

USE OF THE GOULD PROBABILITY MATRIX METHOD OF RESERVOIR DESIGN IN ARID AND SEMI-ARID REGIONS. Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 8A. W91-02306

UNIT HYDROGRAPH TECHNIQUE APPLIED TO SAHELIAN FLOOD MODELING: COMPARISON OF DIFFERENT IDENTIFICATION METHODS (LHYDROGRAMME UNITAIRE APPLIQUE A L'ANALYSE DES CRUES AU SAHEL: COMPARAISON DE DIFFERENTES METHODES D'IDENTIFICATION). Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Montpellier. Centre de Montpellier. P. Ribstein, and T. Lebel. IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 267-279, 7 fig, 1 tab, 11 ref. English summary.

Descriptors: \*Africa, \*Flood forecasting, \*Flood hydrographs, \*Floods, \*Model studies, \*Sahel, \*Unit hydrographs, Catchment areas, Comparison studies, Performance evaluation, Spatial distribution, Spatial variation.

Sahelian floods are caused by heavy convective rainfall displaying some homogeneity at the small watershed scale. For that reason, and because there is no groundwater flow, the unit hydrograph (UH) is well suited to modeling of Sahelian floods. Three UH identifying methods were compared: the Nash UH, a recursive least square (RLS) identification of an autoregressive model with exogenous input (ARX), and the so-called DPFT (Difference Premiere de la Fonction de Transfert), an iterative deconvolution process. The comparison was based on data from two watersheds of less than 20 sq km and it permits an examination of the was based on data from two watersheds of less than 20 sq km and it permits an examination of the validity of the UH concept as applied to the Sahelian floods. The influence of the calibration sample and of the analytic formulation of the production function on the coefficients of the linear transfer function also were studied. In this regard, the DPFT seems to be the most objective of the methods studied. According to the methods used, the UH which were identified were obviously different, but the essential problem remains that of selecting the analytical expression of the production function, especially when the rains present an important spatial variability. (See also W91-02288) (Author's abstract) (Author's abstract) W91-02309

USE OF A DISTRIBUTED MODEL OF A SMALL SAVANNAH CATCHMENT (BOOROBOROTOU, IVORY COAST) UTILISATION D'UN MODELE DISTRIBUE SUR UN PETIT BASSIN VERSANT DE SAVANE (BOOROBOROTOU, COTE D'IVOIRE). Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Montpellier. Centre de Montpellier. For primary bibliographic entry see Field 2A. W91-02310

ANALYSIS OF THE SPEED OF PROPAGA-TION OF FLOOD WAVES (ANALYSE DE LA VITESSE DE PROPAGATION DES ONDES DE

Developpement en Cooperation, Dakar (Senegal). Centre de Dakar.

Centre de Dakar.

J.-P. Lamagast.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 291-305, 10 fig, 4 tab. English summary.

### Streamflow and Runoff-Group 2E

Descriptors: \*Flood forecasting, \*Flood waves, \*Floods, \*Model studies, \*Wave propagation, Flood hydrographs, Gambia River, Mathematical analysis, Mathematical models, Niger River, Simulation, St Venant equation.

lation, St Venant equation.

Analysis of the speed of propagation of flood waves was perfected to set up a model of flood propagation for the River Niger. The analytical methodology developed has led to numerous applications, now in almost daily use. These include: anticipating flow, simulation, real-time management of developments, and height-discharge transformation (non bi-univocal stations). The development of this methodology is described here and each application of the analysis is present in the form of a concrete example. These examples in the form of a concrete example. These examples in the Koulikoro/Kemacina reach; reconstruction of the Gambia River flow at Kouncy; anticipated management flow for the OMVS Management's communal installations at Manantali Dam; and graduation at Boghe station on the Senegal River. A brief summary of the hydraulic elements used to develop the methodology and a diagrammatic approach to it based on St. Venant's equation are presented as well. (See also W91-02288) (Author's abstract) abstract)

HYDRAULIC WORKING OF SHALLOW WATERS IN WEST AFRICA (FONCTIONNE-MENT HYDROLOGIQUE DES BAS FONDS EN AFRIQUE DE L'OUEST).

Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Dakar (Senegal). Centre de Dakar.

For primary bibliographic entry see Field 4A.
W91-02314

UTILIZATION OF THE ARGOS SYSTEM WITHIN THE FRAMEWORK OF THE HYDROMETRIC NETWORK OF BENIN (L'UTILIZATION DU SYSTEME ARGOS DANS LE CADRE DU RESEAU HYDROMETRIQUE DENINOUS BENINOIS)

Developement en Cooperation, Niamey (Niger).
Mission ORSTOM au Niger.

For primary bibliographic entry see Field 7B. W91-02340

GLOBAL MODELLING OF THE RAIN-RUNOFF RELATIONSHIP: A TOOL FOR EVALUATION OF WATER RESOURCES (MO-DELISATION GLOBALE DE LA RELATION PLUIE DEBIT: DES OUTILS AU SERVICE DE L'EVALUATION DES RESSOURCES EN EAU). Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Abidjan (Ivory Coast). Centre ORSTOM d'Adiopodoume.

Coast). Centre ORSTOM d'Adopodoume. E. Servat, and A. Dezetter. IN: The State-of-the-Art of Hydrology and Hy-drogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouaga-dougou, Burkina Faso, 18-23 February 1989. Inter-national Water Resources Association, Urbana, Il-linois. 1990. p 739-749, 5 fig, 2 tab, 10 ref.

Descriptors: \*Hydrologic models, \*Model studies, \*Rainfall-runoff relationships, \*Water supply de-velopment, Burkina Faso, Computer programs, Management planning, Mathematical models, Tu-

Operational versions are described of two conceptual and deterministic models for the rainfall-runoff relationship: CREC and MODGLO. These models are intended to serve as real tools for water project managers. The informatics structure as it applies to microcomputers is emphasized, with a minimum of theoretical discussion. For each model, the productional and transfer functions are discussed and methods for determing parameter values are briefly considered. Programming examples are given. Entries are available for 10-day periods, months, and/or years in the form of tables and graphs to permit the comparison of computed and observed data. Applications are presented for a catchment in

### Group 2E-Streamflow and Runoff

Tunisia and two in Burkina Faso. (See also W91-02288) (Author's abstract) W91-02349

SCIENTIFIC AND TECHNICAL EVALUATION OF MATHEMATICAL MODELS IN THE PLANNING DESIGN AND OPERATION OF HYDROSYSTEMS IN AFRICA.
New Tech International Inst., Dar es Salaam (Tananai)

zania).

A. R. Mfutakamba.

IN: The State-of-the-Art of Hydrology and Hydrogology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 750-771, 22 ref.

Descriptors: \*Africa, \*Design criteria, \*Floods, \*Hydrologic models, \*Model studies, \*Rainfall-runoff relationships, \*Reservoir design, Comparison studies, Dams, Flood forecasting, Mathematical models, Nile River, Performance evaluation, Prediction, Reservoirs, Reviews, Runoff forecasting, Spillways, Stochastic process, Water resources meanagement.

Determination of design and construction floods is critical in the choice of spillway, outlet, and reservoir design, operation, and management, and maintenance of any hydrosystem. Operation security providing a reliable flood warning system and the ability to predict high floods require that valid assumptions be made in the development and application of stochastic and deterministic models for prediction and forecasting. The need for models in the planning, design, operation, and management of water resources systems is discussed. General considerations on river basin models are delineated and some models that have been applied to the River Nile and equatorial lakes in Africa are evaluated. Limitations were identified in the Sacramento Model, Stanford Watershed Model IV, Queen's University Forecasting Model, and Streamflow Model, stanford watershed Model, and Streamflow Synthesis and Reservoir Regulation Model. A real-time runoff forecasting technique was developed that incorporates the soil-plant-atmospheric continthat incorporates the soil-plant-atmospheric contin-uum as a way of facilitating a more realistic predic-tion and forecasting for use in Africa and else-where. The model is basically a conceptual water balance model that eliminates the problems en-countered by other models through the complex soil-plant-atmosphere continuum. The model has been implemented successfully for Big Creek River basin in eastern Ontario and implementation is now in progress for the river basins Nile and Rufiji (corthers and eastern Africa). Zenberi (couthers in progress for the river basins Nile and Rufiji (northern and eastern Africa), Zambezi (southern Africa), and Niger (western Africa). (See also W91-02288) (Rochester-PTT)

TELETRANSMISSION OF HYDROLOGICAL TELETRANSMISSION OF HYDROLOGICAL DATA WITHIN THE FRAMEWORK OF THE PROGRAMME TO COMBAT ONCHOCERCIASIS (TELETRANSMISSION DES DONNEES HYDROLOGIQUES DANS LE CADRE DU PROGRAMME DE LUTTE CONTRE L'ON-CHOCERCOSE).

Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Lome (Togo). Centre ORSTOM du Togo. For primary bibliographic entry see Field 7B. W91-02353

HYDROLOGY AND RIVER CONTROL ON THE NIGER AND SENEGAL.

THE NIGER AND SENEGAL.
Gibb (Alexander) and Partners Ltd., Reading
(England).
J. V. Sutcliffe, and J. B. C. Lazenby.
IN: The State-of-the-Art of Hydrology and Hydrogoology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 846-856, 7 fig. 2 tab, 4 ref.

Descriptors: \*Arid lands, \*Floods, \*Flow augmentation, \*Niger River, \*Senegal River, \*Storage reservoirs, \*Water resources management, Flood control, Flood plains, Hydroelectric plants, Hydrolo-

gy, Irrigation water, Low flow, Mali, Mauritania, Navigation, Rainfall-runoff relationships, Reservoir operation, Seasonal distribution, Senegal, operation,

The Niger and Senegal rivers are extremely impor-tant sources of water for the semi-arid regions in West Africa, and a knowledge of their characteris-tics and the potential for control is vital for Mali, Senegal, and Mauritania in particular. These rivers exhibit extremely variable flows on seasonal and longer-term scales because rainfall in the headwa-ters, which provide the areas of runoff, is highly seasonal and variable. The river flows reflect the rainfall and contribute a source of water to arid areas that varies between intense flooding and exareas that varies between intense flooding and ex-treme low flows. The seasonal inundation of river-ine floodplains forms the basis of traditional land ine floodplains forms the basis of traditional land use, but reservoir storage offers the maintenance of dry season flows and thus the supply of water for hydroelectric power production, irrigation, and improved navigation conditions. The combination of these objectives, achieved by using storage projects for the maintenance of an artificial flood is illustrated by reservoir operation in different years. (See also W91-02288) (Rochester-PTT)

ENVIRONMENTAL AND AGRICULTURAL IMPLICATIONS OF DAM CONSTRUCTION IN THE NIGER VALLEY OF MALI. Gesamthochschule Paderborn (Germany, F.R.).

For primary bibliographic entry see Field 6G. W91-02359

IMPACT OF CLIMATIC CHANGES ON SUR-IMPACT OF CLIMATIC CHANGES ON SUR-FACE WATER RESOURCES IN WEST AND CENTRAL AFRICA (IMPACT DES CHANGE-MENTS CLIMATIQUES SUR LES RE-SOURCES EN EAU DE SURFACE EN AFRI-QUE DE L'OUEST ET CENTRALE: L'EXPER-IENCE DE L'OSTROM).

DEL COSTRUMI, Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Paris. For primary bibliographic entry see Field 7A. W91-02368

THE ENVIRONMENTAL CONDITIONS IN THREE CONSECUTIVE RESERVOIRS OF THE GUADIANA RIVER (W. SPAIN). Barcelona Univ. (Spain). Dept. de Ecologia. For primary bibliographic entry see Field 2H. W91-02372

SPATIAL ORGANIZATION AND POPULA-TION DENSITY OF THE FISH COMMUNITY OF THE LITTER BANKS WITHIN A CENTRAL AMAZONIAN BLACKWATER STREAM. Central Electricity Generating Board, Fawley (England). Marine Biological Unit. For primary bibliographic entry see Field 2H. W91-02414

PHYSICAL, CHEMICAL AND HYDROGRAPH-PHYSICAL, CHEMICAL AND HIDROGRAFTIC INVESTIGATIONS OF AN UPLAND STREAM: A CONTRIBUTION ON THE STANDARDIZATION OF SMALL WATER-COURSES (PHYSIKALISCHE, CHEMISCHE UND HYDROGRAPHISCHE UNTERSUCHUN-GEN EINESC MITTELGEBIRGSBACHES: EIN BEITRAG ZUR TYPISIERUNG KLEINER FLIESSGEWASSER).

Konstanz Univ. (Germany, F.R.). Limnological

Inst. E. Meyer, J. Schwoerbel, and G. C. Tillmanns. Aquatic Sciences AQSCEA, Vol. 52, No. 3, p 236-255, 1990. 9 fig, 7 tab, 30 ref. English summary.

Descriptors: \*Stream discharge, \*Stream profiles, \*Streams, \*Water chemistry, \*Water temperature, Ammonium, Conductivity, Germany, Organic matter, Phosphates, Phosphorus, Seasonal varia-

Temperature, discharge, and chemical parameters were studied in the upper reach of a Black Forest stream (Germany) over a three-year period. Addi-

tionally, investigations of the upstream tributaries and of downstream sites were conducted at some occasions. While monthly and annual means of water temperature exhibited only little year-to-year variations, average annual discharge differed considerably. Total suspended organic matter was correlated to total suspended solids and discharge, orthophosphate and ammonium to temperature. Phosphorus was the only nutrient with a strong seasonal dynamic. Cumulative surface runoff of the upstream tributaries was inversely correlated to total discharge at the gauging station. Concentraupstream tributaries was inversely correlated to total discharge at the gauging station. Concentra-tions of Ca(2+) and Mg(2+) and accordingly, specific conductivity, increased in the longitudinal course of the stream, due to tributaries originating in the adjacent shell limestone and red marl formations. (Author's abstract) W91-02449

FLUVIAL DYNAMICS AND SUCCESSION IN THE LOWER UCAYALI RIVER BASIN, PERU-VIAN AMAZONIA.

Institut Français de Recherche Scientifique pour le Developpement en Cooperation, Lima (Peru). Mission ORSTOM au Perou.

S. Lamotte

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 141-156, June 1990. 3 fig, 6 tab, 41

Descriptors: \*Flood plains, \*Fluvial sediments, \*Forest ecosystems, \*Peru, \*Soil-water-plant relationships, \*Ucayali River Basin, \*Wetlands, Flooding, Reforestation, Vegetation.

During annual flooding of the Amazonian valley, the sediment load of the river, resulting from Andean erosion, is deposited into the river flood basin. In Peruvian Amazonia, the successional vegetation on both the Putumayo River alluvial floodplain and the Madre de Dios River basin have floodplain and the Madre de Dios River basin have been described; there is little available information concerning the forested areas of these wetlands. In the alluvial floodplain of the Ucayali River valley, a succession is evident on the convex banks. On the episodically flooded ridges, graminaean, shrub-by, and arborescent pioneer stages develop. In the swales, which are flooded annually, a graminaean stage preceeds two shrubby pioneer stages. In gen-eral, vegetation, growth, and survival is sensitive to flood time, with the Moraceae evident as the most important pioneer species. In general, a rela-most important pioneer species. In general, a relamost important pioneer species. In general, a rela-tionship between textural soil features and vegetationship between textural soil features and vegeta-tion development was apparent only at the begin-ning of the succession. Species distribution profiles indicated four degrees of perturbation: occasional flooding, annual short flooding, annual long flood-ing, and annual vegetation submersion. If such changes persist, both the structural and floristic features of the flooded forests could be modified, potentially diminishing their future species divers ty. (D'Agostino-PTT) W91-02480

SOUTHWESTERN RIPARIAN PLANT COM-MUNITIES: SITE CHARACTERISTICS, TREE SPECIES DISTRIBUTIONS, AND SIZE-CLASS

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab. For primary bibliographic entry see Field 2H. W91-02491

GROWTH AND DEVELOPMENT OF BALD-CYPRESS/WATER-TUPELO STANDS UNDER CONTINUOUS VERSUS SEASONAL FLOOD-

Louisiana State Univ., Baton Rouge. School of Forestry, Wildlife and Fisheries.

S. G. Dicke, and J. R. Toliver. Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 523-530, June 1990. 4 tab, 9 ref.

Descriptors: \*Baldcypress trees, \*Flooding, \*Forest ecosystems, \*Swamps, \*Tupelo trees, \*Wetland forests, \*Wetlands, Ecological effects, Flood control, Plant growth, Water resources

The bald cypress and water tupelo are the predominant timber species in many flooded areas in the forested wetlands of the southeastern United States. Due to the projected trends of delta subsid-ence, sea-level rise, and human flood control measures, these species will be exposed to longer flood-ing durations. Information on their growth reing durations. Information on their growth response to these changing conditions is necessary to ensure their future survival. The influence of flooding on mixed stands of bald cypress (Taxodium distichum) and water tupelo (Nyssa aquatica) was investigated using two second-growth stands, one continuously flooded (CF) and the other seasonally flooded (SF). In the SF stand, the large bald-cypress was fast-growing, whereas, the water tupelo exhibited high mortality rates. In contrast, bald-cypress growth was slower in the CF stands, and the water tupelo rate was slightly faster. As a result, although the water tupelo lost basal area in the SF stand, it was more competitive against the result, although the water tupelo lost basal area in the SF stand, it was more competitive against the bald-cypress in the CF stand. While a mixture of the two species will potentially be retained under conditions of constant flooding, seasonal flooding may eliminate the water tupelo from the site. (D'Agostino-PTT)
W91-02499

COMPARATIVE STUDY OF THE RESPONSE OF TAXODIUM DISTICHUM AND NYSSA AQUATICA SEEDLINGS TO SOIL ANAERO-BIOSIS AND SALINITY.

Duisiana State Univ., Baton Rouge. Lab. for Wet-nd Soils and Sediments.

G. K. Pezesnki.
Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 531-541, June 1990. 3 fig. 1 tab, 27 ref. Supported by the Louisiana Educational Quality Support Fund, Grant No. LEQSF (1987-90)-RD-A7.

Descriptors: \*Anaerobic conditions, \*Flooding, \*Forest ecosystems, \*Mississippi River, \*Saline water intrusion, \*Salinity, \*Soil-water-plant rela-tionships, \*Swamps, \*Wetland forests, \*Wetlands, Baldcypress trees, Coastal environment, Land management, Plant growth, Tupelo trees.

Recent observations in Mississippi River swamp forests indicate that the combined adverse condi-tions of anaerobiosis, from soil flooding, and intions of anacrotosis, from soil flooding, and in-creased salinity may potentially eliminate flood tolerant tree species that are salt-sensitive. A com-parison of Taxodium distichum and Nyssa aquatica seedling survival demonstrated that anacrobiosis alone resulted in a greater reduction of carbon assimilation rates in T. distichum than in N. aquaassimilation rates in T. distichum than in N. aqua-tica. In a similar response, the combined stress of anaerobiosis and salinity resulted in carbon assimi-lation rates which decreased 46% in T. distichum and 24% in N. aquatica. Based on height growth, both species appear to have the same level of sensitivity, namely a 56% height growth reduction in T. distichum and a 54% height growth reduction in N. aquatica. Both species are also salt-sensitive. From the combined data, it was concluded that both seedling survival and regeneration will be adversly affected in coastal forests where salt water intrusion frequently occurs. (D'Agos-tino-PTT) W91-02500

ASSESSMENT OF BANK SLOPE AS A PRE-DICTOR OF CONSERVATION STATUS IN

RIVER CORRIDORS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology. For primary bibliographic entry see Field 2H. W91-02516

DISTRIBUTION OF CALIFORNIA STREAM FISHES: INFLUENCE OF ENVIRONMENTAL TEMPERATURE AND HYPOXIA. California Univ., Davis. Dept. of Wildlife and Fisheries Biology. For primary bibliographic entry see Field 2H. W91-02518

WATERSHED DELINEATION WITH TRIAN-GLE-BASED TERRAIN MODELS.

Texas Univ. at Austin. Dept. of Civil Engineering. N. L. Jones, S. G. Wright, and D. R. Maidment. Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 10, p 1232-1251, October 1990. 13 fig. 4 tab, 17 ref. NSF Grant MSM-8717452.

Descriptors: \*Drainage patterns, \*Flow models, \*Flow pattern, \*Geomorphology, \*Model studies, \*Surface flow, \*Watersheds, Algorithms, Computer models, Computers, Flow channels, Stream-

An algorithm is presented for tracing the path of steepest descent from a given starting point on a terrain model defined by a triangulated irregular network. This algorithm is then extended to solve network. This algorithm is then extended to solve several problems. The flow patterns for a site are generated by tracing flow paths from a large number of starting points. The approximate stream network or channel network is found by tracing the channels upstream from pits or exit points. Once the stream network is found, the source areas once the stream network is found, the source area or contributing areas for each of the sections of the stream are delineated. The source areas are then used to delineate the watersheds of selected nodes in the channel network. The watersheds of any of the delimiting nodes of the two models tested could be computed and drawn in 1-2 sec or less. The algorithms described are useful for tracing the path of drainage over the terrain surface from points of origin, in the design of site grading, and for generating the geometry required for finite element modeling of surface water flow. (MacKeen-PTT) W91-02525

MISSISSIPPI RIVER-GULF OUTLET, LOUISI-MISSISSIPPI RIVER-GULF OUTLET, LOUISI-ANA: FIELD DATA REPORT. Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.

7. L. Fagerburg.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report HL-90-7, August 1990. 172 p, 54 plates, 70 tab.

Descriptors: "Hydrologic properties, "Louisiana, "Mississippi River, "Shoals, "Suspended sediments, Canals, Flow velocity, Lake Borgne, River flow, Salinity, Water level.

Water levels, current speeds and directions, salinities, and suspended sediment concentrations were measured in the Mississippi River-Gulf Outlet Canal (MRGO), New Orleans, LA, in October and November 1988. The prototype data were collect-November 1988. The prototype data were collected as part of a study to incorporate these data in a numerical model for determination of shoaling rates. The following observations were made: (1) there appears to be a slight decrease in the maximum range of water surface elevation (0.12 ft) from the Chandeleur Sound location to the upper reaches of Lake Borgne; (2) the maximum velocities. rrom the Chandeleur Sound to Catoli to the upper reaches of Lake Borgne; (2) the maximum velocities observed during the surveys occurred at the strength of flood periods. The maximum observed velocity was 3.6 ft/sec at one station on 26 October; (3) suspended sediment concentrations within the MRGO channel were found to be generally greater near the bottom during the strength of flood periods. The suspended sediment concentrations within Lake Borgne were high (106 to 283 mg/L) during windy periods and low (5 to 64 mg/L) during calm periods; (4) salinity values indicated that the lower portion of the MRGO could be described as being penerally well mixed; and (5) correlation of suspended sediment data with satellite data were not successful due to cloud cover during the periods data were obtained. (Lantz-PTT)

WATER RESOURCES FOR CALIFORNIA, WATER YEAR 1989, VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE

Geological Survey, Sacramento, CA. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02624

### Streamflow and Runoff-Group 2E

WATER RESOURCES FOR FLORIDA, WATER YEAR 1989, VOLUME 2A. SOUTH FLORIDA -SURFACE WATER.

Geological Survey, Miami, FL. Water Resources

For primary bibliographic entry see Field 7C. W91-02625

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1989, VOLUME 2B. SOUTH FLORIDA - GROUND WATER.

Geological Survey, Miami, FL. Water Resources ry bibliographic entry see Field 7C. W91-02626

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1989, VOLUME 3A: SOUTH-WEST FLORIDA SURFACE WATER.

Geological Survey, Tampa, FL. Water Resources

For primary bibliographic entry see Field 7C. W91-02627

WATER RESOURCES FOR CALIFORNIA, WATER YEAR 1989, VOLUME 4: NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.

Geological Survey, Sacramento, CA. Water Re-

For primary bibliographic entry see Field 7C. W91-02628

WATER RESOURCES DATA FOR MASSACHU-SETTS AND RHODE ISLAND, WATER YEAR

Geological Survey, Boston, MA. Water Resources

For primary bibliographic entry see Field 7C.

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1989.

Geological Survey, Rolla, MO. Water Resources

For primary bibliographic entry see Field 7C. W91-02630

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1989.

Geological Survey, Helena, MT. Water Resources For primary bibliographic entry see Field 7C.

W91-02631

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1989, VOLUME 1: AT-LANTIC SLOPE BASINS, HUDSON RIVER TO

Geological Survey, West Trenton, NJ. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02632

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1989, VOLUME 2: DELAWARE RIVER BASIN AND TRIBUTAR-IES TO DELAWARE BAY.

Geological Survey, West Trenton, NJ. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02633

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1989, VOLUME 2: LONG ISLAND.

Geological Survey, Syosset, NY. Water Resources

For primary bibliographic entry see Field 7C. W91-02634

### Group 2E-Streamflow and Runoff

WATER RESOURCES DATA FOR PENNSYL-VANIA, WATER YEAR 1989. VOLUME 2: SUS-QUEHANNA AND POTOMAC RIVER BASINS. Geological Survey, Harrisburg, PA. Water Re-For primary bibliographic entry see Field 7C. W91-02635

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1989. Geological Survey, San Juan, PR. Water Re-

For primary bibliographic entry see Field 7C. W91-02636

WATER RESOURCES DATA FOR SOUTH CAROLINA, WATER YEAR 1989. Geological Survey, Columbia, SC. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02637

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1989. Geological Survey, Huron, SD. Water Resources

For primary bibliographic entry see Field 7C. W91-02638

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1989. VOLUME 2: SAN JA-CINTO RIVER, BRAZOS RIVER, SAN BER-NARD RIVER BASINS AND INTERVENING

Geological Survey, Austin, TX. Water Resources

For primary bibliographic entry see Field 7C. W91-02639

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1989. VOLUME 3: COLORADO RIVER, LAVACA RIVER, GUADALUPE RIVER, NUECES RIVER, RIO GRANDE BASINS AND INTERVENING COASTAL BASINS RASINS

Geological Survey, Austin, TX. Water Resources

For primary bibliographic entry see Field 7C. W91-02640

WATER RESOURCES DATA FOR WASHING-TON, WATER YEAR 1989. Geological Survey, Tacoma, WA. Water Re-

sources Div. For primary bibliographic entry see Field 7C. W91-02641

PRELIMINARY ANALYSIS OF WATER AND SOLUTE MOVEMENT BENEATH A CONIF-EROUS HILLSLOPE IN MID-WALES, U. K. Plymouth (England). Dept. of Geographical Sciences.
N. A. Chappell, J. L. Ternan, A. G. Williams, and B. Reynolds.

D. Reynolos.

Journal of Hydrology JHYDA7, Vol. 116, No. 1/

4, p 201-215, August 1990. 9 fig, 34 ref. Natural

Environment Research Council (NERC) Student

Grant GT4/AAPS/86/41.

Descriptors: "Acid rain, "Forest hydrology, "Geochemistry, "Ion transport, "Soil chemistry, "Solute transport, "Surface-groundwater relations, "Wales, "Weathering, Aluminum, Conifers, Fish populations, Groundwater movement, Hydrogen ion concentration, Perched water table, Potable water, Slopes, Soil water, Storm runoff, Streamflow, Water quality.

Streams draining coniferous forests are often loaded with solutes such as hydrogen ion, sulfate, nitrate and aluminum. As a result, fish populations can be reduced and water quality may fall below recommended potable standards. The transport of ions into water-ocurses is governed by the movement of water. Within most temperate and tropical

areas the stream discharge and chemistry, during periods of rapid runoff, is dominated by the exfiltration of water and solutes from stream-side soils. The movement of water to stream-side or riparian areas remains, however, an enigma. Two analytical techniques, the free-surface method and tangenttechniques, the free-surface method and tangent-continuity method, are applied to hydrological properties monitored on a steep coniferous hills-lope, during a selected storm event. Comparison of the ionic concentrations of waters within each component of the hydrological systems, is used to verify the hydrological analysis. Perched water-tables developed within the basal zones of the O/ tables developed within the basal zones of the O/ Ah and Eag soil horizons of the steep podzolic hillslopes, during all major storm events. Most of the rapid response within the riparian zone could be explained by lateral flow in these near-surface be explained by lateral flow in these near-surface soil horizons, particularly in the saturated basal zones. This pathway is corroborated by the similarity of riparian zone and near-surface (or topsoil) chemistries. Relatively low concentrations of monomeric aluminum and relatively high concentrations of chloride, sodium and hydrogen ion were observed within these zones, compared with the subsoil (Bsl and B/C) horizons. (Author's abstract) stract) W91-02746

STORMFLOW HYDROCHEMISTRY OF A SMALL WELSH UPLAND CATCHMENT.
Institute of Terrestrial Ecology, Bangor (Wales). Bangor Research Station.
For primary bibliographic entry see Field 2K.

W91-02748

CONSERVATIVE MIXING OF WATER SOURCES: ANALYSIS OF THE BEHAVIOUR OF THE ALLT A'MHARCAIDH CATCHMENT. OF THE ALLT A'MHARCAIDH CATCHMENT. Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering. For primary bibliographic entry see Field 2K. W91-02756

BLACKWATER PERSPECTIVE ON RIVERINE ECOSYSTEMS

Georgia Univ., Athens. Dept. of Zoology. For primary bibliographic entry see Field 2H. W91-02778

VELOCITY-DISCHARGE RELATIONSHIPS IN THREE LOWLAND RIVERS.

Sheffield Univ. (England). Dept. of Geography. For primary bibliographic entry see Field 7B. W91-02807

LARGE-SCALE FLOODPLAIN MODELLING. Hydrologic Engineering Center, Davis, CA. D. M. Gee, M. G. Anderson, and L. Baird. Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 6, p 513-523, September 1990. 6 fig. 20 ref, append

Descriptors: \*Finite element method, \*Flood fore-casting, \*Flood plains, \*Flooding, \*Model studies, \*Sediment transport, Bed-load discharge, Flood discharge, Flood flow, Flood plain sediments, Flow models, Marshes.

With respect to both discharge and sediment load, the flood plain environment is one of increasing geomorphological attention. A two-dimensional norizontal finite element numerical model (RMA-2) was applied to a 24-km river channel-flood plain reach in West Germany. Initial results indicate that finite element schemes may successfully estimate the depth and lateral extent of inundation in large-scale flood plain applications. The model was found to be robust against field uncertainty in flood plain roughness estimation. Stability of solufound to be robust against field uncertainty in flood plain roughness estimation. Stability of solutions for wetting and drying of large areas was greatly improved by use of the 'marsh' element option. Potentially, the resulting detailed velocity vector distributions and identification of inundation zones throughout storm events could provide an insight into the present day sedimentary environment on the flood plain. (Fish-PTT) WOLLDSON

FLOOD DYNAMICS OF A CONCRETE-LINED, URBAN STREAM IN KANSAS CITY, MISSOU-

Jacksonville State Univ., AL. Dept. of Geography and Geology.

For primary bibliographic entry see Field 4C.

SEASONAL CHANGES IN IRON TRANSPORT AND NATURE OF DISSOLVED ORGANIC MATTER IN A HUMIC RIVER IN NORTHERN FINLAND.

Oulu Univ. (Finland). Dept. of Botany. For primary bibliographic entry see Field 2K. W91-02810

W91-02809

RUNOFF GENERATION IN A SANDY AREA-THE NIZZANA SANDS, WESTERN NEGEV, ISRAEL.

Hebrew Univ., Jerusalem (Israel). Inst. of Earth For primary bibliographic entry see Field 2A. W91-02811

OBSERVATIONS OF THE NIAGARA RIVER THERMAL PLUME (LAKE ONTARIO, NORTH

AMERICA).

National Water Research Inst., Burlington (Ontario). Lakes Research Branch.

A. K. Masse, and C. R. Murthy.

Journal of Geophysical Research (C) Oceans

JGRCEY, Vol. 95, No. 9, p 16,097-16,109, September 15, 1990. 15 fig. 1 tab, 29 ref. National Water

Research Institute Grant No. NKW405-8-2258/01-52

Descriptors: \*Lake Ontario, \*Niagara River, \*Water temperature, Advection, Great Lakes, Seasonal variation, Thermal stratification, Tidal hydraulics, Upwelling, Water circulation

Temperature and velocity data are used to describe the Niagara River discharge into Lake Ontario between April and November 1982. The Niagara River discharge (7000 cu m/s) is usually slightly warmer and therefore less dense than the ambient lake surface water. The density difference varies throughout the year, with the largest density differences being measured in October. Near the river mouth, where the fluid speeds are roughly 1 m/s, the plume is vertically homogeneous. Here advective forces dominate the momentum balance, even in the presence of strong wind forcing. Approximate the momentum balance, even the piume is vertically nomogeneous. Here advective forces dominate the momentum balance, even in the presence of strong wind forcing. Approximately 5 km off shore, the plume separates from the lake bottom as the water depth increases and buoyancy forces become important. At the offshore boundary of the plume, advection, Coriolis force, buoyancy, and wind stress are all important. The Coriolis effect acts to turn the plume anticyclonically and form a right bounded coastal current with speeds of 0.1-0.2 m/s. Strong upwelling-favorable winds force the buoyant plume to spread offshore, thinning the plume as it spreads. Eventually, the plume water is mixed with the lake water by the wind. Strong downwelling-favorable winds concentrate the plume into a narrow and deep coastal current traveling downwind with the coast on its right. Thus, exchange between the plume and the lake is enhanced by upwelling-favorable winds and inhibited by downwelling-favorable winds. (Author's abstract) W91-02832 W91-02832

SEASONAL DYNAMICS IN METHANE EMISSIONS FROM THE AMAZON RIVER FLOOD-PLAIN TO THE TROPOSPHERE. Washington Univ., Seattle, School of Oceanogra-

phy. For primary bibliographic entry see Field 2H. W91-02834

METHANE FLUX FROM THE AMAZON RIVER FLOODPLAIN: EMISSIONS DURING

College of William and Mary, Williamsburg, VA. Dept. of Biology. For primary bibliographic entry see Field 2H.

W91-02837

LOW FLOW ESTIMATION BASED ON RIVER RECESSION RATE.
Clyde River Purification Board, East Kilbride

(Scotland). J. C. Curran.

Journal of the Institution of Water and Environ-mental Management JIWMEZ, Vol. 4, No. 4, p 350-355, August 1990. 6 fig, 11 ref, 2 append.

Descriptors: \*Data interpretation, \*Forecasting, \*Low flow, \*Recession, \*River flow, \*Water pollution control, River mechanics, Statistical analy-

Successful pollution control in a river is fundamentally based on a reliable knowledge of the flow available for dilution of the polluting discharges. Often there may be no available gaging records within a catchment or subcatchment, and it may be necessary to resort to an estimation procedure. Low flow can be predicted through the consideration of the process of Low flow can be predicted through the consideration of: (1) a recession period and its relation to rainfall, and (2) a recession rate and its relation to local soil types. The principal advantages of the recession method are that greater resolution for small catchments is available using the land capability maps compared to the base flow indicator map. Afforestation, influence of tributaries, and catchment storage can all be incorporated explicit-ly in this estimation procedure. (Lantz-PTT) W91-02847

EVALUATION OF REGIONAL FLOOD FRE-QUENCY ANALYSIS WITH A REGION OF IN-FLUENCE APPROACH. Manitoba Univ., Winnipeg. Dept. of Civil Engi-

Water Resources Research WRERAQ, Vol. 26, No. 10, p 2257-2265, October 1990. 4 fig, 1 tab, 11

Descriptors: \*Flood forecasting, \*Flood frequency, \*Gaging stations, \*Network design, \*Regional floods, Drainage patterns, Error analysis, Estimating, Monte Carlo method, Statistical methods.

The region of influence (ROI) approach allows for a unique set of gauging stations to be used in the atsite estimation of extremes for every station in a collection of gaging stations. The starting point for the ROI approach to regionalization is the selection of a distance metric defining the closeness of each station to every other station. Attributes based on physical features of the contributing drainage area for a station or on statistical measures of the data record at each site can be incorporated into the distance metric. The selection of a set of attributes for inclusion in the distance metric from the array of possible attributes can be accomplished using a screening process to identify those attributes that are most indicative of similarity in extreme flow behavior. Threshold values define a cutoff for the inclusion of stations into an ROI for extreme now behavior. Intersolate values define a cutoff for the inclusion of stations into an ROI for a site. Finally, a weighting function reflecting the relative closeness to the site of each station in a site's ROI is determined. Through a Monte Carlo experiment, the ROI approach provides improved at-site estimates of extreme flow quantiles in terms of network average root mean squared error and comparable results for bias. The method is further shown to have attractive features for estimating extremes for unusual sites in a network of gauging stations. (Brunone-PTT) W91-02856

RELIABILITY ESTIMATION IN MODELING WATERSHED RUNOFF WITH UNCERTAIN-TIES.

TIES.
Rutgers - The State Univ., Piscataway, NJ. Dept. of Civil and Environmental Engineering.
C. S. Melching, B. C. Yen, and H. G. Wenzel. Water Resources Research WRERAQ, Vol. 26, No. 10, p 2275-2286, October 1990. 5 fig., 4 tab, 34 ref. Union Carbide A environmental Carbide Associations. ref. Union Carbide Agricultural Company contract No. 81065-C.

Descriptors: \*Hydrologic models, \*Model studies, \*Rainfall-runoff relationships, \*Runoff, \*Uncer-

tainty, \*Watersheds, Discharge capacity, Mathematical models, Probability distribution, Seasonal variation, Vermilion River.

The reliability of simulation results produced by watershed runoff models is a function of uncertainties in nature, data, model parameters, and model structure. A cumulative distribution function (CDF) and/or a probability density function of the magnitude of the predicted peak discharge accounting for the various uncertainties from different contributing factors provides a framework for using a reliability analysis method (such as first-order second-moment techniques or Moste Carlo using a reliability analysis method (such as first-order second-moment techniques or Monte Carlo simulation) to evaluate the combined effect of the uncertainties on the reliability of output hydro-graphs from hydrologic models. The peak dis-charge probability for the Vermilion River water-shed in Illinois using the HEC-1 watershed model sned in litinois using the HEC-1 watershed model yields stochastic output due to the uncertainties in the basic variables of the model. The CDF of the estimation provides a visual means of assessing the estimation reliability. In the Vermilion River watershed model, results indicated that prediction of runoff resulting from non-summer rainstorms is more reliable than that for summer storms; the more reliable than that for summer storms; the major contributors to unreliability of the model predictions are the initial loss and continuing loss rate parameters in HEC-1; and, hydrograph parameters and model correction factors contribute relatively little to prediction uncertainty. The study of the reliability of predictions from watershed models provides useful information on the stochastic nature of output from deterministic models subject to uncertainties and identifies the relative subject to uncertainties and identifies the relative contribution of the various uncertainties to unrelia-bility of model predictions. (Brunone-PTT) W91-02858

SPATIAL UNIFORMITY OF POWER AND THE ALTITUDINAL GEOMETRY OF RIVER

Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab. V. Kapoor.

Water Resources Research WRERAQ, Vol. 26, No. 10, p 2303-2310, October 1990. 2 fig, 3 tab, 18 ref. Army Research Office Grant 26220-GS.

Descriptors: \*Entropy, \*Flow rates, \*Geomorphology, \*Model studies, \*River mechanics, \*River systems, \*Scale factors, Climates, Mathematical systems, \*Scale fa models, River flow.

River networks are hypothesized to adjust their geometries in the altitudinal space to achieve a state of maximum spatial uniformity of power. A model developed to study the spatial variability of power shows that the notion of uniformity is linked to both minimum variance and maximum information theoretic entropy. The hypothesis relates the scaling exponent of link heights to the scaling exponents of instantaneous flows and predicts the superiority of the self-similar model over alternative models of link heights in channel networks. Self-similar models enable link power to be distributed with greater spatial uniformity than it is distributed with greater spatial uniformity than it is in the alternative models. The ability of the selfsimilar link height model to distribute power more uniformly in space should be tested for basins from different climatic regions for which both geomorphic data and flow data are available. (Author's abstract) W91-02860

WIDTH AND DEPTH OF SELF-FORMED STRAIGHT GRAVEL RIVERS WITH BANK VEGETATION.

Tokyo Inst. of Tech. (Japan). Dept. of Civil Engineering. S. Ikeda, and N. Izumi.

S. Ikeda, and N. Izumi.
Water Resources Research WRERAQ, Vol. 26,
No. 10, p 2353-2364, October 1990. 14 fig. 20 ref,
append. Ministry of Education and Culture of
Japan Grant No. 01550398.

Descriptors: \*Alluvial channels, \*Channel morphology, \*Gravel rivers, \*Riparian vegetation, \*River mechanics, \*Vegetation effects, Flow velocity, Hydrologic models, River systems, Shear stress, Stream banks.

### Streamflow and Runoff-Group 2E

The influence of bank vegetation on the stable channel cross-sectional geometry of stable, straight gravel rivers is studied theoretically. Singular perturbation and matched asymptotic expansion techniques are employed to derive the lateral distribution of depth-averaged fluid velocity and the bed shear stress. A condition of sediment incipient motion is imposed at the junctions of the bed and the banks to derive the stable depth, and a formula the banks to derive the stable depth, and a formula for resistance to flow is used to obtain the stable width. The theory reveals that a thicker vegetation yields a larger depth and a smaller width. Increas-ing discharge increases the effect of vegetation. The analysis agrees reasonably well with available field data in natural gravel rivers in Colorado and England. (Author's abstract) W91-02865

INCORPORATING HILLSLOPE EFFECTS INTO THE GEOMORPHOLOGIC INSTANTA-NEOUS UNIT HYDROGRAPH CH2M/Hill, Reston, VA.

L. D. Van der Tak, and R. L. Bras Water Resources Research WRERAQ, Vol. 26, No. 10, p 2393-2400, October 1990. 4 fig, 18 ref, append. National Science Foundation Grant

Descriptors: \*Geomorphology, \*Hydrograph anal-ysis, \*Rainfall-runoff relationships, \*Slopes, \*Unit hydrographs, Discharge capacity, Drainage densi-ty, Flow rates, Probability distribution, Statistical analysis.

Use of gamma distributions of stream holding times, rather than the traditional exponential distribution, results in geomorphologic instantaneous unit hydrograph (GIUHs) that better fit data-based IUHs. In this paper, hillslope effects are incorporated into the gamma GIUH (GGIUH) model by assuming that the hillslope travel distance in an area of a given order is approximated by the inverse of twice the local drainage density and introducing a hillslope velocity term. A method of moments fitting procedure is used to estimate the Channel and hillslope velocity terms in the GGIUH model from the moments of rainfall input and basin discharge output. Results showed that hillslope velocities are 2 orders of magnitude smallhillslope velocities are 2 orders of magnitude small-er than channel velocities. The values found for the latter are reasonable given the range of values found in the literature for channel velocities. Similarly, the hillslope velocity term found by the method of moments procedure matches macropore velocities reported in the literature. (Brunone-PTE) PTT) W91-02868

PREDICTING RUNOFF FROM RANGELAND CATCHMENTS: A COMPARISON OF TWO

Agricultural Research Service, Boise, ID. North-Watershed Research Center. B. P. Wilcox, W. J. Rawls, D. L. Brakensiek, and

J. R. Wight. Water Resources Research WRERAQ, Vol. 26, No. 10, p 2401-2410, October 1990. 6 fig, 4 tab, 37

Descriptors: \*Agricultural watersheds, \*Hydrologic models, \*Land use, \*Model studies, \*Prediction, \*Rainfall-runoff relationships, \*Runoff, \*Runoff forecasting, \*Watersheds, Comparison studies, Infiltration, Land management, Mathematical models, Parameterization, Resource management

Two different hydrology models, both designed to predict runoff from ungaged rural catchments, were compared. One model is the commonly used and conceptually simple Soil Conservation Service curve number method. The other model is a process oriented model based on the Green and Ampt equation. The Green and Ampt model employs equation. The Green and Ampt model employs newly developed techniques for parameterizing the Green and Ampt equation based on readily available soil and vegetation information. Annual, monthly and daily predicted runoff were compared to observed on six uncalibrated rangeland catchments located in Texas, Oklahoma, Arizona, Nebraska and Idaho. Model parameterization was

### Group 2E-Streamflow and Runoff

based strictly on individual catchment characteris-tics. No model calibration was performed. Results indicate that the Green and Ampt model a potenindicate that the Green and Ampt model a poten-tially useful tool for predicting runoff. These re-sults are important because they demonstrate the utility of complex physically based models as man-agement tools for predicting land use impacts to runoff and infiltration. (Author's abstract)

CLIMATIC INFLUENCES ON STREAMFLOW VARIABILITY: A COMPARISON BETWEEN SOUTHEASTERN AUSTRALIA AND SOUTHEASTERN UNITED STATES OF AMERICA. Melbourne Univ., Parkville (Australia). Dept. of Civil and Agricultural Engineering. For primary bibliographic entry see Field 2B. W91-02877

LACK OF THEORETICAL BASIS FOR PRE-DICTING RATE AND PATHWAYS OF RECOV-ERY. Virginia Polytechnic Inst. and State Univ., Blacks-

burg. Center for Environmental and Hazardous Material Studies.

For primary bibliographic entry see Field 5G. W91-02895

RECOVERY OF LOTIC COMMUNITIES AND ECOSYSTEMS FROM DISTURBANCE-A NAR-RATIVE REVIEW OF CASE STUDIES. Environmental Research Lab., Duluth, MN. For primary bibliographic entry see Field 5G. W91-02897

PHYSICAL HABITAT TEMPLATE OF LOTIC SYSTEMS: RECOVERY IN THE CONTEXT OF HISTORICAL PATTERN OF SPATIOTEM-PORAL HETEROGENEITY. Colorado State Univ., Fort Collins. Dept. of Biol-

ogy. For primary bibliographic entry see Field 2H. W91-02902

DISTURBANCE REGIMES, RESILIENCE, AND RECOVERY OF ANIMAL COMMUNITIES AND HABITATS IN LOTIC ECOSYSTEMS. North Carolina Univ. at Chapel Hill. Dept. of Biology. For primary bibliographic entry see Field 2H. W91-02903

REGIONAL FRAMEWORK FOR ESTABLISH-ING RECOVERY CRITERIA.

NSI Technology Services Corp., Corvallis, OR. For primary bibliographic entry see Field 2H.

BIOGEOCHEMICAL CYCLING CON-STRAINTS ON STREAM ECOSYSTEM RE-

Oak Ridge National Lab., TN. Environmental Sciences Div.

For primary bibliographic entry see Field 2H. W91-02906

DISTURBANCE AND RECOVERY OF LARGE

DISTURBANCE AND RECOVERY OF LARGE FLOODPLAIN RIVERS. Illinois Natural History Survey, Havana. Stephen A. Forbes Biological Station. For primary bibliographic entry see Field 2H. W91-02907

ROLE OF REFUGIA IN RECOVERY FROM DISTURBANCES: MODERN FRAGMENTED AND DISCONNECTED RIVER SYSTEMS. Pacific Northwest Forest and Range Experime Station, Corvallis, OR. Forestry Sciences Lab. For primary bibliographic entry see Field 2H. W91-02908

RECOVERY PROCESSES IN LOTIC ECOSYSTEMS: LIMITS OF SUCCESSIONAL THEORY.

Arizona State Univ., Tempe. Dept. of Zoology. For primary bibliographic entry see Field 2H. W91-02909

ISLAND BIOGEOGRAPHICAL THEORY: CAN IT BE USED TO PREDICT LOTIC RECOVERY

RATES. Austin Peay State Univ., Clarksville, TN. Center for Field Biology. J. A. Gore, and A. M. Milner. Environmental Management EMNGDC, Vol. 14, No. 5, p 737-753, 1990. 4 fig, 1 tab, 135 ref.

Descriptors: \*Biogeography, \*Ecological effects, \*Habitat restoration, \*Lotic environment, \*Model studies, \*Stream biota, Classification, Mathematical nalysis, Species diversity, Succession, Theoretical

Classic island biogeographic theory predicts that Classic island biogeographic theory predicts that equilibrium will be reached when immigration and extinction rates are equal. These rates are modified by the number of species in a source area, the number of intermediate islands, the distance to a recipient island, and the size of the intermediate islands. This general model has been variously modified and proposed to be a stochastic process with minimal competitive interaction or heavily deterministic Because disturbance frequency, sedeterministic. Because disturbance frequency, sedeterministic. Because disturbance frequency, se-verity, and intensity vary in their effect on commu-nity dynamics, disturbance levels should first be defined before evaluating the applicability of island biogeographical theory. A classification system is suggested consisting of four disturbance level based on recovery patterns. Level 1 disturbances completely destroy communities with no upstream or downstream sources of colonizers. Level 2 disor downstream sources of communities but leave up-stream and downstream colonization sources. Level 3 disturbances result in reduction of species abundance and diversity along a stream reach. Level 4 disturbances result in reduction of abundance and diversity in discrete patches. Island biogeographical models seem appropriate to recovery by secondary processes after level 3 and 4 disturbof secondary processes after level 3 and 4 disturbances, where competition may be an important organizing factor, while models of numerical abundance and resource tracking are probably of better use where community development is by primary succession. (Lantz-PTT) W91-02910

APPLICATION OF ECOLOGICAL THEORY TO DETERMINING RECOVERY POTENTIAL OF DISTURBED LOTIC ECOSYSTEMS: RESEARCH NEEDS AND PRIORITIES.

AUSTIN PRELID AND PRIORITIES. Austin Peay State Univ., Clarksville, TN. Center for Field Biology. For primary bibliographic entry see Field 2H. W91-02911

MODELING CHANNEL BED TRANSIENTS USING EXPLICIT F-D SCHEMES.

Ottawa Univ. (Ontario). Dept. of Civil Engineer-

ing.

B. Morse, and R. D. Townsend.

Journal of Hydraulic Engineering (ASCE)

JHENDS, Vol. 116, No. 11, p 1345-1356, November 1990. 7 fig. 1 tab, 12 ref. Natural Science and Engineering Research Council of Canada grant no.

7443; Environmental Canada contract no. KE-144-

Descriptors: \*Channel flow, \*Channel morphology, \*Finite difference methods, \*Hydraulic engineering, \*Hydraulic transients, \*Mathematical models, \*Model studies, \*River beds, Bed load, Froude number, Mud wave, Numerical analysis, Sand waves, Sediment transport, Viscosity.

Nonlinearities of bed transients of finite height have been documented through numerical modeling using finite difference (F-D) schemes. The numerical characteristics of two explicit F-D mencal characteristics of two explicit F-D
schemes, namely: de Vries's pseudoviscosity modified-Lax and Fromm's zero-average-phase-error
schemes were used as a starting point. The performance of de Vries's scheme depends primarily
on the relationship of the pseudoviscosity term to
the bed Courant number selected and the spatial

resolution used to discretize the bed wave, whereas the performance of Fromm's scheme depends on the bed Courant number chosen for the simulation. The optimal choice of these numerical parameters The optimal choice of these numerical parameters is a function of the bed wave height, the wave shape, and the Peclet and Froude numbers. These schemes were used in numerical simulations to determine the nonlinear behavior of a sinusoidaldetermine the nonlinear operation of a sinusoical-shaped bed transient of finite height. The simulated motion of the bed were compared with that ob-tained by (linear small-amplitude) analytical meth-ods; correction factors for both effective bed wave celerity and attenuation were incorporated as func-tions of the dimensionless wave height, the Peclet tions of the dimensionless wave height, the recited and Froude numbers. Even where there is very little diffusion present in the physical system, good results can be achieved if the viscosity term is chosen carefully. Convergence is easier to achieve when the Froude number and the dimensionless bed wave amplitude are small, and when the Peclet. number is large. In most of the cases tested, the developed equations provided a good representation of the governing equations. (Author's ab-W91-02918

RESISTANCE TO FLOW IN STEEP ROUGH STREAMS.

Universidad de Los Andes, Merida (Venezuela).

Universidad de Los Andes, Merida (Venezuela). Dept. of Civil Engineering.

J. Aguirre-Pe, and R. Fuentes.
Journal of Hydraulic Engineering (ASCE)
JHENDS, Vol. 116, No. 11, p 1374-1387, November 1990. 7 fig, 2 tab, 33 ref. Council for the
Development of Sciences, Humanities and Technology (CDCHT) of the Universidad de Los
Andes Grant I-204.

Descriptors: \*Flow resistance, \*Hydraulic roughness, \*Mountain streams, \*Open-channel flow, Boundary layers, Chezy equation, Darcy-Weisbach equation, Flow velocity, Flumes, Turbulent

Flow resistance and velocity profiles associated with flow in open channels with small-scale roughness is customarily described in terms of boundary-layer theory. A theory of resistance to flow in steep, rough streams was developed that takes into account the existence of a highly turbulent wake zone near the bed of a very rough boundary. Two zones were identified in the field. The first one, close to the top of the bed, contains overlapping wakes generated by protruding roughness elements. In the second zone, located above the first one, the velocity distribution is described in terms of a logarithmic profile. Flume data were used to check the validity of this formulation. The compound velocity profile allows for equations to check the validity of this formulation. The compound velocity profile allows for equations to obtain Darcy-Weisbach and Chezy factors. The proposed approach is compared with the results of four previous theories using data obtained from several mountain rivers withough flow in actual mountain rivers is more complicated than the idealized case treated in the study, the formulation provides equations that allow accurate prediction of flow resistance with a mean error of plus-orminus 15%. (Author's abstract) W91-02920

GAMMA-AUTOREGRESSIVE MODELS FOR STREAM-FLOW SIMULATION.

Pontificia Univ. Catolica de Chile, Santiago. Dept.

Pontificia Univ. Catolica de Chile, Santiago. Dept. of Hydraulic Engineering.

B. Fernandez, and J. D. Salas.
Journal of Hydraulic Engineering (ASCE)
JHENDS, Vol. 116, No. 11, p 1403-1414, November 1990. 2 fig, 6 tab, 30 ref. Fondo Nacional de Ciencia y Tecnologia de Chile, Proyecto FONDE-CYT 516/1989; Colorado Agricultural Experiment Station Project N. 645.

Descriptors: \*Model studies, \*Regression analysis, \*Streamflow data, \*Streamflow forecasting, \*Time series analysis, Annual distribution, Computer models, Simulation analysis, Statistical analysis.

Since hydrologic time series in general, and streamflow series, in particular, are dependent and not normally distributed, use of the classical autor-

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egressive and moving average models to represent such series requires transformation of the original series into a normal distribution before applying the model. On the other hand, gamma-autoregressive (GAR) models assume that the underlying series is dependent with a gamma marginal distribution and the models do not require variable transformation. However, the models require the estimation of certain statistics generally leading to biased estimates of the model parameters. A procedure has been developed for bias correction, based on computer simulation studies, applicable for estimating parameters of GAR(1) models. Applications of the proposed procedure was made to annual streamflow series of several rivers. The GAR(1) model, when used in conjunction with the proposed estimation procedure, is an attractive alternative for synthetic streamflow simulation, is simple to use, and does not require any transformation of the original data. (Author's abstract) W91-02922

TURBULENT SHEAR STRESS IN HETEROGE-NEOUS SEDIMENT-LADEN FLOWS. Korea Inst. of Construction Technology, Seoul. For primary bibliographic entry see Field 2J. W91-02923

FIRST STEP AWAY FROM LACEY'S REGIME EQUATIONS.
For primary bibliographic entry see Field 8B.
W91-02924

BED CONFIGURATIONS IN STEADY UNIDIR-ECTIONAL WATER FLOWS: PART I. SCALE MODEL STUDY USING FINE SANDS, Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences. L. A. Boguchwal, and J. B. Southard. Journal of Sedimentary Petrology JSEPAK, Vol. 60, No. 5, p 649-657, September 1990. 5 fig. 2 tab, 17 ref

Descriptors: \*Bed load, \*Channel morphology, \*Flow models, \*Hydraulic models, \*Model studies, \*Particle size, \*Sedimentary structures, \*Temperature effects, Dunes, Flow velocity, Flumes, Plane flow, Ripple marks, River beds, Sand, Sedimentation, Water temperature.

Reynolds-Froude scale modeling using hot-water flows to model cold-water flows was applied to the study of unidirectional-flow bed configurations in a large, thermally-insulated laboratory flume. Three different water temperatures, ranging from 14 to 75 C, provided three different scale ratios, from 1.1 to 2.3. Effective sand sizes, scaled to 10 C water, were about 0.12 mm, 0.18 mm, and 0.28 mm. Relative to 10 C water, use of hot water multiplied the effective flow depth and all flume dimensions by factors of up to 2.3, the flow velocity by factors of up to 1.5, and the water discharge by factors of up to 8. The effective dimensions of the flume, scaled to 10 C water temperature, ranged up to over 26 m long and 2 m wide, with a flow depth of up to 0.5 m. In the coarser sand sizes (0.17-0.26 mm), three bed phases were observed: ripples, dunes, and upper-regime plane bed. Dunes tended to be two-dimensional (crests straight and continuous) at low flow velocities and three-dimensional (crests sinuous and discontinuous) at relatively high flow velocities, except that at flow velocities transitional between ripples and dunes the bed showed a complex intermingling of irregular larger dunelike bed forms and smaller irregular ripples. In the dune range, ripples were prominently superimposed at relatively low flow velocities. (See also W91-029276 and W91-02927) (Author's abstract) W91-029276

BED CONFIGURATIONS IN STEADY UNIDIR-ECTIONAL WATER FLOWS: PART II. SYN-THESIS OF FLUME DATA.

Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences.

J. B. Southard, and L. A. Boguchwal. Journal of Sedimentary Petrology JSEPAK, Vol. 60, No. 5, p 658-679, September 1990. 19 fig, 3 tab,

56 ref

Descriptors: \*Channel flow, \*Channel morphology, \*Flow models, \*Hydraulic models, \*Literature review, \*River beds, \*Sediment transport, \*Sedimentary structures, Bed load, Boundary layers, Dunes, Flow velocity, Flumes, Graphical analysis, Particle size, Plane flow, Ripple marks, Sedimentation, Shear stress, Water temperature.

Existing data on bed states have not yet been thoroughly exploited to reveal relationships among the various bed phases. Therefore, data from 39 flume studies that report equilibrium bed configuration as well as water temperature, flow depth, flow velocity, and sediment size were used to develop the best approximation to the relationships among bed phases (ripples, dunes, lower-regime plane bed, upper-regime plane bed, and antidunes) produced by flows of water over loose sediments. A three-axis graph with dimensionless measures of mean flow depth, mean flow velocity, and sediment size along the axes was used. The relationships were illustrated as a series of depth-velocity sections and velocity-size sections through the dimensionless diagram. Boundaries between stability fields of the bed phases were drawn as smooth surfaces that minimize misplacement of data points. A large subset of the data, for which reliable values of bed shear stress are reported, was used to represent the stability relationships of the bed phases in a graph of dimensionless boundary shear stress against dimensionless sediment size. The graph shows substantial overlapping of the fields for dunes, upper plane bed, and antidunes owing to the decrease in bed shear stress in the transition from dunes to plane bed with increasing flow velocity. The topology of bed-phase boundaries was guided by the relationships shown in the dimensionless depth-velocity-size diagram. (See also W91-02926

BED CONFIGURATIONS IN STEADY UNIDIR-ECTIONAL WATER FLOWS: PART III. EF-FECTS OF TEMPERATURE AND GRAVITY. Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences. J. B. Southard, and L. A. Boguchwal. Journal of Sedimentary Petrology JSEPAK, Vol. 60, No. 5, p 680-686, September 1990. 7 fig, 1 tab,

Descriptors: \*Bed load, \*Channel morphology, \*Flow models, \*Gravity flow, \*Hydraulic models, \*Sediment transport, \*Sedimentary structures, \*Sedimentation, \*Temperature effects, Channel flow, Flow velocity, Graphical analysis, Mars, Model studies, Water temperature.

Understanding of the mechanics of temperature-related changes in sediment transport is still rudimentary. A change in bed configuration caused by a change in water temperature without any change in flow and sediment variables in a unidirectional flow was analyzed in the context of a dimension-less depth-velocity-size diagram. Bed states that differ only in water temperature are termed temperature-related states. These are attainable from any given state solely by a change in water temperature. Such a set of bed states forms a curve in the dimensionless depth-velocity-size diagram. This curve, a straight line in a log-log-log plot, is termed a temperature-change line. To predict the change in bed state consequent upon a change in water temperature-related state lying along the temperature in the dimensionless depth-velocity-size diagram. Three examples from the literature were analyzed in this way to show how such changes in bed configuration can be put into the context of existing stability relationships among the various bed phases, without however addressing the general dynamical problem of why those relationships are as they are. The effect of the acceleration of gravity on the bed configuration was also examined from the standpoint of the dimensionless depth-velocity-size diagram. The results show that in a hypothetical open-channel water flow on Mars a given transition between two adjacent bed phases with increasing flow velocity (e.g., ripples to

dunes) would take place at a lower velocity on Mars than on earth, by a factor of 0.74. (See also W91-02925 and W91-02926) (Author's abstract) W91-02927

FLUME EXPERIMENTS ON THE TRANS-PORT OF HEAVY MINERALS IN GRAVEL-BED STREAMS.

Massachusetts Inst. of Tech., Cambridge. Dept. of Earth and Planetary Sciences. For primary bibliographic entry see Field 2J. W91-02928

### 2F. Groundwater

SOLUTE TRANSPORT THROUGH SATURATED SOILS: A STUDY OF THE PHYSICAL NON-EQUILIBRIUM MODEL.

Claremont Graduate School, CA. Dept. of Mathematics.

For primary bibliographic entry see Field 5B. W91-02090

GLACIATION AND SALINE-FRESHWATER MIXING AS A POSSIBLE CAUSE OF CAVE FORMATION IN THE EASTERN MIDCONTINENT REGION OF THE UNITED STATES: A CONCEPTUAL MODEL.

Illinois State Geological Survey Div., Champaign. S. V. Panno, and W. L. Bourcier. Geology GLGYBA, Vol. 18, No. 8, p 769-772, August 1990. 3 fig., 1 tab, 40 ref.

Descriptors: \*Caves, \*Geohydrology, \*Glaciohydrology, \*Karst hydrology, \*Saline groundwater, \*Saline-freshwater interfaces, Aquifer characteristics, Calcite, Chemical reactions, Geologic history, Limestone, Undersaturation.

Cave formation in the phreatic zone of limestone aquifers involves the widening of mechanically opened joints, fractures, and bedding planes by groundwater that is slightly undersaturated with respect to calcite. The mixing of two groundwaters of dissimilar salinities is one of many mechanisms proposed to explain calcite undersaturation in water descending within the phreatic zone. Spatial and temporal relations among intracratonic basins, karstic terrain, and continental glaciation suggest that Pleistocene glaciation may have initiated the discharge of saline waters from the margins of these basins. Glaciation-induced discharge of saline waters could result from the consolidation of sediments due to the overlying pressure of glacial ice, and flushing of underlying aquifers as a result of bottom melting in recharge areas of basin aquifers. The upward migration of basin-derived saline waters into near-surface aquifers would result in the mixing of saline waters with infiltrating glacial meltwater and meteoric water. The development of a vertically restricted zone of mixing of saline and fresh water in limestone aquifers would result in the dissolution of limestone; this mechanism could be responsible for the formation, or at least the initiation of, some caves and associated karst features in the midcontinent region. (Author's abstract)

PERSISTENCE OF ALDICARB RESIDUES IN THE SANDSTONE AQUIFER OF PRINCE EDWARD ISLAND, CANADA.

Canada Centre for Mineral and Energy Technology, Elliot Lake (Ontario). Elliot Lake Lab. For primary bibliographic entry see Field 5B. W91-02160

STIMULATION OF BIOLOGICALLY ACTIVE ZONES (BAZ'S) IN POROUS MEDIA BY ELECTRON-ACCEPTOR INJECTION,

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering. For primary bibliographic entry see Field 5G. W91-02161

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TRANSFORMATION KINETICS OF TRACE-LEVEL HALOGENATED ORGANIC CON-TAMINANTS IN A BIOLOGICALLY ACTIVE ZONE (BAZ) INDUCED BY NITRATE INJEC-TION.

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering. For primary bibliographic entry see Field 5G. W91-02162

MODELING THE MASS-TRANSFER RATE OF RADIOACTIVE COBALT FROM A SYNTHET-IC GROUNDWATER TO VOLCANIC TUFF MEDIA.

Howard Univ., Washington, DC. Dept. of Chemical Engineering. For primary bibliographic entry see Field 5B. W91-02163

ADSORPTIVE SOLUTE TRANSPORT IN FRACTURED ROCK: ANALYTICAL SOLUTIONS FOR DELTA-TYPE SOURCE CONDI-

TIONS. Kyoto Univ., Osaka (Japan). Research Reactor Inst. For primary bibliographic entry see Field 5B. W91-02164

TILL GENESIS AND HYDROGEOLOGICAL PROPERTIES.

Norges Landbrukshoegskole, Aas. S. Haldorsen, and J. Kruger. Nordic Hydrology NOHYBB, Vol. 21, No. 2, p 81-94, 1990. 9 fig. 33 ref.

Descriptors: \*Geohydrology, \*Glacial aquifers, \*Glacial sediments, \*Groundwater movement, \*Sedimentation, \*Till, Geologic fractures, Hydraulic conductivity, Saturated flow, Sediment sorting.

Hydrogeological properties of tills are highly dependent upon factors as grain-size distribution, compaction, orientation of particles, presence of fractures, and occurrence of sorted sediments. These factors are dependent upon the till forming processes. Lodgement tills formed under active, temperate sliding glaciers are usually compact, rather homogeneous, and in many cases they are fractured. Melt-out tills deposited in connection with stagnant ice are in most cases less dense, have a lower percentage of fine-grained particles, and a higher abundance of sorted sediment lenses. Flow tills, which are mainly formed by a secondary flow of supraglacial debris, are commonly very variable and may have a low content of fine-grained components, a low degree of compaction, and are often closely associated with sorted glaciofluvial sediments. Till genesis is in many cases difficult to interpret, and an objective description of all main characteristics of the till is important in hydrogeological studies. The lodgement till has a lower effective porosity than the melt-out and flow tills due to its finer grain sizes and higher compactness. The saturated hydraulic conductivity of the lodgement till is lower, and dependent upon the fracture pattern. In melt-out tills and flow tills the occurrence of well sorted sediments will in many cases control the hydraulic conductivity. In all till types the structural properties are most important for the saturated water flow. (Author's abstract)

METHODS FOR MEASURING THE SATURAT-ED HYDRAULIC CONDUCTIVITY OF TILLS. Norges Landbrukshoegskole, Aas. For primary bibliographic entry see Field 7B. W91-02166

SATURATED HYDRAULIC CONDUCTIVITY OF SCANDINAVIAN TILLS.

Chalmers Univ. of Technology, Goeteborg (Sweden). B. B. Lind, and L. Lundin. Nordic: Hydrology NOHYBB, Vol. 21, No. 2, p 107-118, 1990. 10 fig. 1 tab, 33 ref.

Descriptors: \*Geologic fractures, \*Glacial sediments, \*Groundwater movement, \*Hydraulic con-

ductivity, \*Saturated flow, \*Till, Porosity, Sediment sorting, Sedimentation.

There is a distinctive difference in hydraulic properties between the upper horizons of Scandinavian till soil and the deeper C-horizon. The hydraulic conductivity has been studied in different soil profile types, mainly podzolic variants. In the topsoil there are correlations from grain size and porosity to hydraulic conductivity. Both porosity and hydraulic conductivity are stratified with depth. Often high conductivity appears in the upper soil horizons decreasing with depth to low values at about one meter. This pattern varies with soil type. The soils vary with topographic location as does the groundwater level. Published data on hydraulic conductivity in the C-horizon of sandy-silty tills in Scandinavia covers a wide range, from about 5 x to to the minus fourth power m/s to 5 x ten to the minus fourth power m/s, with a mean of 3 x ten to the minus sixth power m/s. The correlation between porosity and hydraulic conductivity, is well as between mean grain size and hydraulic conductivity, is well as between mean grain size and hydraulic conductivity, is weak in the C-horizon. It is concluded that the sediment structure has a decisive influence on the hydraulic conductivity of till. A model of the relationship between particle orientation (in relation to water flow direction), the porosity in the pore-size interval of 30-95 micrometers, and the hydraulic conductivity suggests that if the particle orientation is near parallel to the flow, the porosity in the relevant interval has a greater impact on the hydraulic conductivity than if the orientation is transverse to the flow. (Tappert-PTT)

SATURATED HYDRAULIC CONDUCTIVITY OF CLAYEY TILLS AND THE ROLE OF FRACTURES.

Technical Univ. of Denmark, Lyngby. Inst. for Teknisk Geologi. J. Fredericia.

Nordic Hydrology NOHYBB, Vol. 21, No. 2, p 119-132, 1990. 2 fig, 51 ref. Danish National Council for Technology Grant No. 5.26.13.05.

Descriptors: \*Denmark, \*Fracture permeability, \*Glacial sediments, \*Groundwater movement, \*Hydraulic conductivity, \*Radioisotopes, \*Till, Geologic fractures, Glaciohydrology, Porosity, Sediment sorting, Sedimentation.

The number of published hydraulic conductivities of clayey till in Denmark is still small, and more data is needed. Information concerning fracture systems in till is particularly important; these systems can be revealed by geological mapping of fracture distribution, spacing, and depth of occurrence. Controlled tracer tests can provide information concerning actual transport velocities and the importance of diffusion, and isotope studies can give the age of the porewater. In thick clayey till, tritium possesses possibilities as a fracture indicator because of diffusion. Existing data show a difference of 1-2 orders of magnitude in the vertical hydraulic conductivity between values from laboratory measurements and field measurements. Based on new data, field observations, and comparison with North American studies this lack of agreement is concluded to be primarily due to fractures in the till. Hydraulic tests with direct measurements in the aquitard, such as alug tests and pumping tests, can provide bulk hydraulic conductivities for different volumes. Hydrologic and chemical data are necessary to understand how effective a barrier clayey till is against migration of pollution. (Tappert-PTT)

MODELING OF MULTICOMPONENT TRANS-PORT WITH MICROBIAL TRANSFORMA-TION IN GROUNDWATER: THE FUHRBERG CASE.

Waterloo Univ. (Ontario). Inst. for Ground Water Research.

For primary bibliographic entry see Field 5B. W91-02180

UNIVERSAL SCALING OF HYDRAULIC CON-DUCTIVITIES AND DISPERSIVITIES IN GEO-LOGIC MEDIA.

Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.

Water Resources Research WRERAQ, Vol. 26, No. 8, p 1749-1758, August 1990. 3 fig, 43 ref. NRC Contract No. NRC-04-86-123.

Descriptors: \*Dispersion, \*Dispersivity, \*Ficks Law, \*Geochemistry, \*Geohydrology, \*Hydraulic conductivity, \*Model studies, \*Path of pollutants, \*Scale factors, Fractal mathematics, Fracture permeability, Mathematical models, Model testing, Numerical models, Porous media, Solute transport.

Chemical transport in geologic media is known to be strongly influenced by spatial variations in hydraulic conductivity. Apparent longitudinal dispersivity data from a variety of hydrogeologic settings are assumed to represent a continuous hierarchy of log hydraulic conductivity fields with mutually uncorrelated increments, each field having its own exponential autocovariance, associated integral scale, and variance that increases as a power of scale. Such a hierarchy is shown theoretically to form a self-similar random field with homogeneous increments. Regardless of whether or not the underlying assumption is valid, one can justify interpreting the apparent dispersivities in a manner consistent with a recent quasi-linear theory of non-fickian and Fickian dispersion in a homogenous media which supports the notion of a self-similar hierarchy a posteriori. The hierarchy is revealed to possess a semivariogram and a fractal dimension which can be viewed as a universal scaling rule, about which large deviations occur due to local influences, including the existence of discrete natural scales at which log hydraulic conductivity is statistically homogenous. As such homogeneity is at best a local phenomenon occurring intermittently over narrow bands of the scale spectrum, one must question the utility of associating medium properties with representative elementary volumes and relying on Fickian models of dispersion over more than relatively narrow scale intervals. Porous and fractured media appear to follow the same idealized scaling rule for both flow and transport, raising a question about the validity of many distinctions commonly drawn between such media. Finally, the data suggest that conditioning transport models from the hierarchy. (Author's abstract) W91-02183

FLOW TO A HEATED BOREHOLE IN POROUS, THERMOELASTIC ROCK: ANALYSIS.

Sandia National Labs., Albuquerque, NM. Fluid Mechanics and Heat Transfer Div. I. D. F. McTigue.

Water Resources Research WRERAQ, Vol. 26, No. 8, p 1763-1774, August 1990. 6 fig. 1 tab, 16 ref, append. United States DOE Contract No. DE-ACO4-76DP00789.

Descriptors: \*Boreholes, \*Fluid flow, \*Geohydrology, \*Geothermal studies, \*Groundwater movement, \*Temperature effects, Diffusion, Heat flow, Mathematical analysis, Pore pressure, Porous media, Rock properties, Thermal conductivity.

Exact solutions are obtained for fluid flow induced by the heating of a borehole. The rock is modeled as a fluid-saturated, porous, thermoelastic medium. The temperature and pore pressure fields are governed by a pair of diffusion equations, which are coupled through a source term in the pressure equation proportional to the temperature rate. The pressure profile exhibits a maximum that grows in magnitude and propagates away from the borehole. For a constant heat flux applied as an instananeous step, the fluid flux to the borehole takes a finite initial value, and decays monotonically. When the heat flux exhibits a finite rise time, the fluid flux is initially zero, rises to a maximum, and then decays. At late time, the inverse of the fluid flux is linear in ln(t); this observation can be ex-

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ploited to estimate the permeability and fluid diffusivity of low-permeability rock. Sample calculations for Westerly granite shows modest success. (Author's abstract) W91-02185

COMPARISON OF DARCIAN FLOW IN COR-RESPONDING FLAT AND FOLDED SUR-FACES.

Geological Survey, Denver, CO. E. Weiss.

Water Resources Research WRERAQ, Vol. 26, No. 8, p 1775-1785, August 1990. 5 fig, 1 tab, 9 ref,

Descriptors: \*Aquifer characteristics, \*Darcys law, \*Fluid flow, \*Geohydrology, \*Geologic formations, \*Groundwater movement, \*Model studies, Boundary conditions, Geologic control, Hydraulic conductivity, Hydraulic head.

Flat surfaces are frequently used as models of aquifers even though aquifers are folded and have a variation in hydraulic head along the vertical. To account for aquifer folds in groundwater flow models, the equation describing Darcian flow in a general surface is derived. The equation is used to calculate steady state hydraulic head distributions for corresponding folded and flat surfaces. Each flat surface has the same hydraulic conductivity distribution and boundary conditions as the corredistribution and boundary conditions as the corre-sponding folded surface. The folded surfaces have folds similar to the folds of selected aquifers and have folds that have much larger changes in slope. folds similar to the folds of selected aquifers and have folds that have much larger changes in slope. The largest difference in hydraulic head caused by all folding is only about 0.5% of the largest difference in hydraulic head across each surface. Hydraulic head distributions in surfaces composed of sinusoidal synclines and anticlines indicate that the effect of folds is not cumulative. Because of the smaller areal extent and the fact that the effect of a sequence of folds is not cumulative, the minor folds on the generate substantially larger hydraulic head do not generate substantially larger hydraulic head difference: than the major folds. (Author's abstract) W91-02186

RESPONSE OF THE WATER LEVEL IN A WELL TO EARTH TIDES AND ATMOSPHERIC LOADING UNDER UNCONFINED CONDI-

Geological Survey, Menlo Park, CA. S. Rojstaczer, and F. S. Riley. Water Resources Research WRERAQ, Vol. 26, No. 8, p 1803-1817, August 1990. 8 fig, 3 tab, 22

Descriptors: \*Aquifers, \*Atmospheric pressure, \*Earth tides, \*Geohydrology, \*Groundwater level, \*Groundwater movement, \*Unconfined aquifers, \*Wells, Confined aquifers, \*Hydraulic conductivity, Hydraulic head, Unsaturated zone.

ductivity, Hydraulic head, Unsaturated zone.

The response of the water level in a well to earth tides and atmospheric loading under unconfined conditions can be explained if the water level is controlled by the aquifer response averaged over the saturated depth of the well. Because vertical averaging tends to diminish the influence of the water table, the response is qualitatively similar to the response of a well under partially confined conditions. When the influence of well bore storage can be ignored, the responses to earth tides is strongly governed by a dimensionless aquifer frequency Q'u. The response to atmospheric loading is strongly governed by two dimensionless vertical fluid flow parameters: a dimensionless unsaturated zone frequency R, and a dimensionless aquifer frequency Qu. The differences between Q'u and Qu are generally small for aquifers which are highly sensitive to earth tides. When Q'u and Qu are large, the response of the well to earth tides and atmospheric loading approaches the static response of the aquifer under confined conditions. At small values of Q'u and Qu, well response to earth tides and atmospheric loading is strongly influenced by attenuation and phase shift of the pneumatic pressure signal in the unsaturated zone. The presence of partial penetration

retards phase advance in well response to earth tides and atmospheric loading. When the theoreti-cal response of a phreatic well to Earth tides and atmospheric loading is fit to the well response atmospheric loading is fit to the well response inferred from cross-spectral estimation, it is possi-ble to obtain estimates of the pneumatic diffusivity of the unsaturated zone and the vertical hydraulic conductivity of the aquifer. (Author's abstract) W91-02188

CURIOUS BEHAVIOR OF A GROUNDWATER

FLOW MODEL.
Butler Univ., Indianapolis, IN. Dept. of Mathematical Science J. P. Fink.

Water Resources Research WRERAQ, Vol. 26, No. 8, p 1833-1836, August 1990.

Descriptors: \*Boundary conditions, \*Flow models, \*Groundwater movement, \*Mathematical models, \*Model studies, \*Water table fluctuations, Capillary zone, Diffusion, Drawdown, Free surfaces, Unconfined aquifers.

In formulating mathematical models of unconfined groundwater flow, the nature of the transition zone between saturated and dry aquifer material has been handled in a variety of ways. The simple between saturated and dry aquifer material has been handled in a variety of ways. The simple formulation obtained by assuming a free surface is not valid in many cases. A useful approach is to apply a capillarity correction term c to the free surface formulation. For sudden drawdown the problem has been expressed as an initial boundary value problem (IBVP). There are striking differences in the behavior of solutions to the IBVP which depend on the value of the capillarity correction term. For c=0, the differential equation which reduces to the diffusion equation has a smoothing effect on the initial data. On the other hand, for c>0 the differential equation preserves the discontinuity resulting from the incompatibility of the initial and boundary data. In physical terms, any initial fluctuations in the water table disappear almost immediately if c>0 and persist indefinitely if c>0. The properties exhibited by the IBVP suggest that it should be used with care. The diffusion equation equation which results when c=0 should not be viewed as the proper limiting case when c>0. The change in the highest order term makes the difference between a parabolic problem and a pseudoparabolic problem. (Tappert-PTT) W91-02190

WATER-QUALITY CHARACTERISTICS OF THE COLUMBIA PLATEAU REGIONAL AQ-UIFER SYSTEM IN PARTS OF WASHINGTON, OREGON, AND IDAHO. Geological Survey, Tacoma, WA. Water Re-sources Div.

sources Div.

W. C. Steinkampf.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS

Water-Resources Investigations Report 87-4242, 1989. 37p, 27 fig, 4 tab, 12 ref.

\*Regional Aquifer Systems, \*Columbia Plateau, \*Regional Aquifer System Analysis, \*Washington, \*Water quality, Grande Ronde Basalt, Groundwat-er, Saddle Mountains Basalt, Wanapum Basalt, Water type. Descriptors: \*Aquifer systems, \*Columbia Plateau,

Water quality data for the period 1982 through 1983 from about 350 wells in three Miocene basalt units in the Columbia Plateau regional aquifer system, Washington, show that the quality of groundwater generally is suitable for most uses. The dominant water type is calcium magnesium bicarbonate at shallow depths, and evolves toward sodium bicarbonate at depth. Calcium magnesium sulfate chloride type waters occur less commonly and are associated with shallow wells, the absence of a thick overburden, and agricultural land use. Dissolved-solids concentrations generally are less than 500 mg/L. Water in the Saddle Mountains unit has a mean dissolved-solids concentration of 488 mg/L. Nitrogen species and sulfate concentraunit has a mean dissolved-solus concentration or 488 mg/L. Nitrogen species and sulfate concentra-tions relate to overburden thickness and land use. Water in the Wanapum unit, below the Saddle Mountains unit, has a mean dissolved-solids concentration of 270 mg/L. High nitrogen concentra-tions (10 mg/L or greater) occur mostly in wells

with depths less than 300 ft in areas with little or no overburden in the central part of the plateau. The Grande Ronde unit, below the Wanapum, has the lowest mean dissolved-solids concentrations, 230 mg/L, and nitrogen concentrations ar less than 2 mg/L. (USGS)
W91-0223

ALTITUDE OF POTENTIOMETRIC SURFACE. FALL 1985, AND HISTORIC WATER-LEVEL CHANGES IN THE MEMPHIS AQUIFER IN WESTERN TENNESSEE

Geological Survey, Nashville, TN. Water Resources Div. W. S. Parks, and J. K. Carmichael

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Water-Resources Investigations Report 88-4180, 1990. 8p, 2 fig, 1 pl, 18 ref.

Descriptors: \*Aquifers, \*Groundwater, \*Ground-water movement, \*Memphis Aquifer, \*Potentio-metric level, \*Tennesse, \*Water level fluctua-tions, Groundwater recharge, Memphis Sand,

Recharge to the Memphis aquifer of Tertiary age is from precipitation on the outcrop, which forms a broad belt across western Tennessee, or by down-ward infiltration of water from the overlying fluviward infiltration of water from the overlying fluvial deposits of Tertiary and Quaternary age and alluvium of Quaternary age. In the outcrop-recharge belts, where the Memphis aquifer is under water-table conditions, the potentiometric surface is complex and generally resembles the topography. To the west of the outcrop-recharge belt where the Memphis aquifer is confined, the potentiometric surface gently slopes westward, and the water moves slowly in that direction. A major cone of depression in the potentiometric surface in the Memphis area is the result of long-term (1986-present) pumping at municipal and industrial well fields. Water levels in the Memphis aquifer have declined at average rates ranging from less than 0.1 fields. Water levels in the Memphis aquifer have declined at average rates ranging from less than 0.1 to 1.3 ft/year during the period 1928-85. The largest declines have been in the Memphis area where withdrawals averaged about 191 million gal/day in 1985. Near the center of the major cone of depression in the Memphis area water levels ceased to decline in about 1975, and the center of the cone decline in about 1975, and the center of the cone essentially has stabilized. Away from the center of the cone, water levels are still declining at a low rate, and the cone is still expanding as a result of the long-term effects of pumping. (USGS) W91-02224

GEOLOGY AND GROUND-WATER RE-SOURCES OF THE COCKFIELD FORMATION IN WESTERN TENNESSEE. Geological Survey, Nashville, TN. Water Re-sources Div.

sources Div.

sources Liv.

W. S. Parks, and J. K. Carmichael.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS

Water-Resources Investigations Report 88-4181, 1990. 17p, 2 pl, 5 fig, 4 tab, 21 ref.

Descriptors: \*Aquifers, \*Cockfield Formation, \*Geology, \*Groundwater availability, \*Ground-water resources, \*Tennessee, \*Water quality, Aq-uifer characteristics, Cockfield Aquifer, Geologic formations, Groundwater movement, Groundwater recharge, Potentiometric level, Stratigraphy, Structural geology, Water level fluctuations, Water supply development.

The Cockfield Formation of the Claiborne Group of Tertiary age underlies approximately 4,000 sq mi in western Tennessee. The formation consists primarily of lenticular beds of very fine to coarse sand, silt, clay, and lignite. The Cockfield Formation has been extensively eroded, and the original sand, but, condition has been extensively eroded, and the original thickness is preserved only in a few areas where the formation ranges from 235 to 270 ft in thickness. Recharge to the Cockfield aquifer is from precipitation on sparse outcrops or by downward infiltration of water from the overlying fluvial conditions. Textiary and Quaternary age and alluviations of Textiary and Quaternary age and alluviations are considered. um of Quaternary age or, where present, the over-lying Jackson Formation of Tertiary age. Data

### Group 2F-Groundwater

from two observation wells indicate that water levels have risen at average rates of about 0.5 and 0.7 ft/year during the period 1980-85. Water from the Cockfield aquifer is a calcium bicarbonate type that contains low concentrations of most major constituents, and generally is suitable for most uses. Dissolved-solids concentrations range from 44 to Dissolved-solids concentrations range from 44 to 218 mg/L. Data from two aquifer tests indicate transmissivities of 2,500 and 6,000 sq ft/day and storage coefficients of 0.0003 and 0.0007, respec-tively. The Cockfield aquifer presently provides small to moderate quantities of water for several public and industrial water supplies and small quantities to numerous domestic and farm wells. Withdrawals for public and industrial supplies in 1983 averaged about 3.3 million gal/day. (USGS) W91-02225

ESTIMATES OF GROUND-WATER FLOW COMPONENTS FOR LYMAN LAKE, APACHE COUNTY, ARIZONA, WITH A SECTION ON GEOCHEMISTRY OF SURFACE WATER AND GROUND WATER IN THE LYMAN LAKE AREA BY FREDRICK N. ROBERTSON. Geological Survey, Tucson, AZ. Water Resources

Div.
D. J. Bills, and H. W. Hjalmarson.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4151, 1990. 55p, 12 fig, 4 tab, 21 ref. Project no. AZ092.

Descriptors: \*Arizona, \*Lakes, \*Lyman Lake, \*Surface-groundwater relations, Groundwater, Hydrologic budget, Isotopic tracers, Water qual-

Lyman Lake is an irrigation reservoir on the Little Colorado River near St. Johns, Arizona. The main sources of water for the lake are streamflow in the Little Colorado River and spring flow from the underlying Coconino aquifer. The use of groundunderlying Coconino aquifer. The use of ground-water at two electric-power generating stations in the Lyman Lake area may affect the quantity of spring flow at the lake. The water-budget method and water-chemistry and isotope data were used to compute the quantity of groundwater flow to and from Lyman Lake. Components of flow used in the water budget analysis included evaporation from the lake, transpiration from dense vegetation, seepage through the dam, streamflow in and out of the lake, precipitation on the lake, and measured or estimated changes in lake storage for 7-day periods in 1985 and 1986. Geochemical data included major ions trace elements, and the stable isotopes in 1985 and 1986. Geochemical data included major ions, trace elements, and the stable isotopes of hydrogen and oxygen. During the study, the potentiometric level in the Coconino aquifer was above the lake level at the upstream end of the lake and below lake level at the downstream end. Groundwater flow from the lake is related to the head difference between the aquifer and the lake at the downstream end of the lake. Discharge from the aquifer was an average of 5.7 cu ft/sec at Salado Springs downstream from Lyman Lake and an estimated 6.0 cu ft/sec in Lyman Lake. The relation between computed groundwater inflow an estimated 6.0 cu tr/sec in Lyman Lake. The relation between computed groundwater inflow and the difference in head between the aquifer and the lake at the upstream end was not statistically significant. The interpretation of the geochemical data supports the conceptual model of the water budget, and the calculated percentages are within the range of the results of the water budget comparison. (USGS) W91-02231

GROUND-WATER SELECTED GROUND-WATER INFORMA-TION FOR THE PASCO BASIN AND ADJA-CENT AREAS, WASHINGTON, 1986-1989. Geological Survey, Tacoma, WA. Water Re-sources Div.

Sources Liv.

B. W. Drost, K. M. Schurr, and W. E. Lum.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS

Open-File Report 89-228, 1989. 91p, 2 fig, 2 tab, 8

Descriptors: "Hydrologic data, "Pasco Basin, "Washington, "Water resources data, "Well data, Data collections.

The U.S. Geological Survey, in cooperation with the United States Department of Energy, conduct-

ed a study of the Pasco basin and adjacent areas, Washington, in support of the Basalt Waste Isola-tion Project at the Hanford site, Washington. The purpose of the study was to develop a data set that would help define the groundwater-flow system of the Pasco Basin. This report contains the basic the Pasco Basin. This report contains the basic data, without interpretation, that were collected from the start of the project in February 1986 through January 1989. Information presented is from the U.S. Bureau of Reclamation, State of Washington Department of Ecology, US Army Corps of Engineers, Kennewick Irrigation District, and the Survey, and consists of well location and construction data, records of water levels in the wells, and aquifer designations for each well. The aquifer designation represents the geohydrologic unit to which the well is reported to be open. (USGS) (USGS) W91-02233

BIBLIOGRAPHY OF U.S. GEOLOGICAL SURVEY REPORTS ON THE WATER RE-SOURCES OF FLORIDA, 1886-1989. Geological Survey, Tallahassee, FL. Water Resources Div.

For primary bibliographic entry see Field 10C. W91-02237

WATER-QUALITY, WELL CONSTRUCTION, AND GROUNDWATER LEVEL DATA FOR AN INVESTIGATION OF RADIONUCLIDES IN GROUND WATER, HICKMAN AND MAURY COUNTIES, TENNESSEE.

GROUDGIAL SURVEY, Nashville, TN. Water Re-

e Div

G. E. Hileman. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-190, 1990. 13p, 2 fig, 2 tab, 9

Descriptors: \*Groundwater, \*Radioisotopes, \*Radon, \*Tennessee, \*Water quality data, \*Water resources data, Chattanooga Shale, Geochemistry, Phosphatic limestone, Radionuclides, Trace

Water quality, well construction, and groundwater level data were collected for an investigation of radionuclides in groundwater in Maury and Hickman Counties, Tennessee. Seventeen wells and 3 springs were sampled in Hickman County, and 20 wells were sampled in Hickman County, and 20 wells were sampled in Maury County. Samples from each site were analyzed for radionuclides, common and trace inorganic ions, indicators of redox conditions, selected nutrients, total organic carbon, and selected physical characteristics. Well-construction data were obtained to help determine the source of the water. Where possible, groundwater level measurements were made for each well sampled. Samples were collected from May 1989 through mid-August 1989. Data are presented in tables. Maps of each county show the location of the sites sampled. (USGS)

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1989, VOLUME 3B: SOUTH-WEST FLORIDA GROUND WATER. Geological Survey, Tampa, FL. Water Resources

For primary bibliographic entry see Field 7C. W91-02240

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1989.

Geological Survey, Salt Lake City, UT. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02241

ALTITUDE OF POTENTIOMETRIC SURFACE, FALL 1985, AND HISTORIC WATER-LEVEL CHANGES IN THE FORT PILLOW AQUIFER IN WESTERN TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.

W. S. Parks, and J. K. Carmichael.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4048, 1990. 8p, 3 fig, 12 ref.

Descriptors: \*Fort Pillow aquifer, \*Groundwater, \*Groundwater recharge, \*Potentiometric level, \*Tennessee, \*Water level fluctuations, Aquifers, Fort Pillow Sand, Groundwater movement.

Recharge to the Fort Pillow aquifer of Tertiary age in Tennessee is from precipitation on the outcrop, which forms a narrow belt across western Tennessee, and by downward infiltration of water from the overlying fluvial deposits of Tertiary and Quaternary age and alluvium of Quaternary age or, where the upper confining unit is absent, from the overlying Memphis aquifer of Tertiary age. The potentiometric surface in the Fort Pillow aquifer slopes gently westward from the outcron-recharge. slopes gently westward from the outcrop-recharge area, and the water moves slowly in that direction. area, and the water moves slowly in that direction. A depression in the potentiometric surface in the Memphis area is the result of past pumping at Memphis Light, Gas and Water Division (MLGW) well fields (1924-74), and past and present pumping at an industrial well field at Memphis, and the municipal well field at West Memphis, Ark. Water levels in areas affected by pumping have declined at average rates ranging from 0.4 to 0.9 ft/year during the period 1945-85. The greatest rate of decline was as much as 4.0 ft/year between 1945 and 1954 in an observation well in a well field of MLGW at Memphis. In 1971, MLGW ceased pumping from the Fort Pillow aquifer at this well field, and between 1972 and 1976, water levels rose about 28 ft in this well. Withdrawals from the Fort Pillow aquifer in western Tennessee in 1985 averaged about 12 million gal/day. (USGS)

HYDROGEOLOGIC RECONNAISSANCE OF THE SWOPE OIL SUPERFUND SITE AND VI-CINITY, CAMDEN AND BURLINGTON COUNTIES, NEW JERSEY.

Geological Survey, Trenton, NJ. Water Resources

G. J. Barton, and M. Krebs Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Open-File Report 89-402, 1990. 247p, 5 fig, 1 pl, 14 ta, 35 ref, 4 append.

Descriptors: \*Groundwater, \*Groundwater pollu-tion, \*Hydrogeology, \*Hydrology, \*New Jersey, \*Water quality data, \*Well data, Coastal plains, Groundwater level, Groundwater movement, Hy-drogeologic units, Hydrologic properties, Poto-mac-Raritan-Magothy Aquifer System, Water level fluctuations, Water use.

Groundwater beneath a former chemical reclamation facility in New Jersey is contaminated with
metals and organic compounds. The off-site migration of these compounds has not been studied;
however, a nearby public-supply well is contaminated, and a public-supply well 1,400 ft downgradient from the site may be threatened. The study
area, in the New Jersey part of the Atlantic Coastal Plain, is underlain by alluvial deposits composed
of gravel, sand, sitl, and clay. These deposits comprise the water table aquifer, the confining units,
and the confined aquifer throughout the study
area. The water table beneath the Swope Oil Superfund site is approximately 17 ft below sea level
and groundwater levels throughout the study area
are below the stage of the Delaware River. The
aquifer system is recharged by precipitation, leakage of water through confining units, and the
water induced from the Delaware River. Five
public supply-well fields, primarily adjacent to the
Delaware River, and four waste disposal sites with
observation well networks are located in the study
area. Both the water table and confined aquifers
are contempared in several locations. The concernarea. Both the water table and confined aquifers are contaminated in several locations. The concenare contaminated in several locations. The concentration of metals and/or purgeable organic compounds in more than 20 wells exceeds the U.S. Environmental Protection Agency primary drinking-water standard and the New Jersey Department of Environmental Protection recommended drinking water criteria. Selected data from wells and test borings are presented, including well con-

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struction details; drillers', geologists', and geo-physical logs; water levels; specific-capacity and slug test data; and chemical analysis of groundwat-er samples. (USGS) W91-02249

GROUND-WATER LEVELS IN ARKANSAS, **SPRING 1990.** 

Geological Survey, Little Rock, AR. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02250

DIFFERENCE BETWEEN THE POTENTIOME-TRIC SURFACE OF THE AQUIA AQUIFER OF SEPTEMBER 1986 AND SEPTEMBER 1988 IN SOUTHERN MARYLAND.

Geological Survey, Towson, MD. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02255

DIFFERENCE BETWEEN THE POTENTIOME-TRIC SURFACE OF THE MAGOTHY AQUI-FER OF SEPTEMBER 1986 AND SEPTEMBER 1988 IN SOUTHERN MARYLAND. Geological Survey, Towson, MD. Water Re-

sources Div. For primary bibliographic entry see Field 7C. W91-02256

POTENTIOMETRIC SURFACE OF THE AQUIA AQUIFER IN SOUTHERN MARY-LAND DURING SEPTEMBER 1988. Geological Survey, Towson, MD. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02257

WATER RESOURCES DATA FOR ARKANSAS,

WATER YEAR 1989. Geological Survey, Little Rock, AR. Water Resources Div.

For primary bibliographic entry see Field 7C. W91-02261

GROUNDWATER OWNERSHIP AND CONTROL IN INDIAN COUNTRY.
Du Bey Law Firm, Seattle, WA.
For primary bibliographic entry see Field 6E.
W91-02277

NORTHEAST GLACIAL AQUIFERS.

NORTHEAST GLACIAL AQUIFERS. Regional Aquifer Systems of the United States. Papers presented at AWRA Symposium on Monitoring, Modeling, and Mediating Water Quality, May 17-20, 1987, Syracuse, New York. AWRA Monograph Series No. 11, 1988. 156 p. Edited by Allan D. Randall and A. Ivan Johnson.

Descriptors: \*Geohydrology, \*Glacial aquifers, \*Groundwater resources, \*Regional Aquifer-Systems Analysis, \*Surface-groundwater relations, \*Symposium, Aquifers, Glacial drift, Glacial hydrology, Lithology, Radioactive tracers, Runoff.

Papers are presented from the AWRA Symposium on Monitoring, Modeling, and Mediating Water Quality, held May 17-20, 1987. The following topics are discussed: Northeast Glacial Aquifers RASA Project; Upland runoff as a major source of recharge to stratified drift in the glaciated northeast; Estimation of water available for recharge to sand and gravel aquifers in the glaciated northeastern United States; Evaluation of the continuous seismic-reflection methods for determining the thickness and lithology of stratified drift in the glaciated northeast; Continuous seismic-reflection profiling of glacial drift along the Susquehanna, Chemung, and Chenango Rivers, south-central New York and North-Central Pennsylvania; Geochemistry of the stratified-drift aquifer in the Kill-New 10TK and NOrth-Central Pennsylvania; Geo-chemistry of the stratified-drift aquifer in the Kill-buck Creek Valley west of Wooster, Ohio; and, Use of Oxygen-18 and deuterium mass-balance analysis to evaluate induced recharge to stratified drift aquifers. (See W91-02281 thru W91-02287) (Lantz-PTT)

W91-02280

NORTHEAST GLACIAL AQUIFERS RASA PROJECT—AN OVERVIEW OF RESULTS THROUGH 1987.

Geological Survey, Albany, NY. Water Resources

Geological Survey, Albany, N.T. water Resources Div.
A. D. Randall, and A. I. Johnson.
IN: The Northeast Glacial Aquifers. Regional Aquifer Systems of the United States. Papers presented at AWRA Symposium on Monitoring, Modeling, and Mediating Water Quality, May 17-20, 1987, Syracuse, New York. AWRA Monograph Series No. 11, 1988. p 1-15, 7 fig, 1 tab, 35 ref.

Descriptors: \*Geohydrology, \*Glacial aquifers, \*Groundwater resources, \*Regional Aquifer-Systems Analysis, \*Surface-groundwater relations, Aquifers, Geochemistry, Groundwater movement, Groundwater recharge, New England, New York,

Snowmelt.

The Northeast Glacial Aquifers project, one of the US Geological Survey's many Regional Aquifers Systems Analyses (RASA), must evaluate a multitude of local aquifers that interact with regional streams but not with each other. These local aquifers were deposited by glacial meltwater and occur chiefly in valleys. The water they contain is generally less highly evolved geochemically than that in bedrock, probably because their small extent and high permeability allows the water to move through them quickly. Studies of the distribution of aquifers within the glacial drift have led to conceptual models of typical aquifer geometries in each of several subregions in the glaciated Northeastern United States. Although such models can help guide evaluation of local aquifers, local data are still needed; one promising new technique for obtaining data is marine seismic reflection, which can delineate aquifer geometry beneath the large streams and lakes that are potential sources of induced recharge. The exchange of water between stratified-drift aquifers and streams is a vital feature of the hydrology of the glaciated Northeast. Runoff from uplands is a major source of recharge to stratified drift under natural conditions, and recharge induced from streams by pumping can far exceed all natural recharge. Rates of induced rerecharge induced from streams by pumping can far exceed all natural recharge. Rates of induced reexceed all natural recharge. Rates of induced re-charge and streambed properties may be calculated from streamflow measurements, or from vertical temperature profiles beneath the stream, diurnal fluctuation in dissolved oxygen in the streambed, isotopic and dissolved chemical differences be-tween river water and groundwater, or calibration of groundwater flow models. During periods of low flow, natural streamflow consists of ground-water that is discharged into stream channels, its magnitude is a function of the area of surficial sand magnitude is a function of the area of surficial sand and gravel in the basin, wetland area, and precipiand gravet in the basin, wetland area, and precipitation. A new modeling technique routes rejected recharge and groundwater discharge from upland hillsides to locations where it can infiltrate sand and gravel on the valley floor. (See also W91-02280) (Author's abstract)

UPLAND RUNOFF AS A MAJOR SOURCE OF RECHARGE TO STRATIFIED DRIFT IN THE GLACIATED NORTHEAST.

Geological Survey, Bow, NH. Water Resources

Geological Survey, Bow, 1971. Water Resonance Div. D. J. Morrissey, A. D. Randall, and J. H. Williams. In: The Northeast Glacial Aquifers. Regional Aquifer Systems of the United States. Papers presented at AWRA Symposium on Monitoring, Modeling, and Mediating Water Quality, May 17-20, 1987, Syracuse, New York. AWRA Monograph Series No. 11, 1988. p 17-36. 8 fig, 5 tab, 27 ref.

Descriptors: \*Geohydrology, \*Glacial aquifers, \*Glacial drift, \*Groundwater recharge, \*Groundwater resources, \*Regional Aquifer-Systems Analysis, \*Stratified drift, \*Surface-groundwater relations, Aquifers, Case studies, Infiltration, New Hampshire, New York, Pennsylvania, Permeability, Runoff.

Most large valleys in the glaciated northeastern United States contain stratified drift that consists partly of sand and gravel. Precipitation on the

valley floor has been considered to be the chief source of natural recharge to sand and gravel aquifers, augmented by some groundwater flow through the poorly permeable bedrock and till that form the adjacent uplands. Recent studies of several localities suggest, however, that well over half the natural recharge to stratified-drift aquifers can be derived from upland runoff, by infiltration of streamflow and unchanneled runoff from uplands as well as by lateral flow of groundwater. For example, at least 60% of recharge to a valley in central New York, computed by two independent methods, was ascribed to upland sources. About 58% of recharge to a nearby locality was from upland sources, according to a test application of a valley floor has been considered to be the chief 58% of recharge to a nearby locality was from upland sources, according to a test application of a detailed method for estimating aquifer yields in south-central New York. More than 85% of recharge to a valley aquifer in north-central Pennsylvania was from upland sources, chiefly infiltration from upland tributaries, which averaged 10.5 cu ft/sec and which prevented persistent declines in water level in a well field new one of the tributaries except when the tributary channel was dry ies except when the tributary channel was dry. Nearly 75% of the groundwater that discharged from stratified drift to a 4-mile reach of the Saco from stratified drift to a 4-mile reach of the Saco River valley in New Hampshire during two peri-ods of low flow was concurrently replaced by seepage of tributary streamflow, and upland sources contributed 59% of the natural recharge as simulated by a steady-state groundwater flow model of the valley. Review of these case histories indicates that, in regions of high topographic relief, upland sources account for about 60% of the re-charge to stratified drift in valleys 1 mile wide, and more in narrower valleys. In regions of low relief more in narrower valleys. In regions of low relief, seepage losses from tributaries may be small under natural (nonpumping) conditions. (See also W91-02280) (Author's abstract) W91\_02282

ESTIMATION OF WATER AVAILABLE FOR RECHARGE TO SAND AND GRAVEL AQUIFERS IN THE GLACIATED NORTHEASTERN UNITED STATES.

Geological Survey, Albany, NY. Water Resources

F. P. Lyford, and A. J. Cohen.

F. P. Lyford, and A. J. Cohen. In: The Northeast Glacial Aquifers. Regional Aq-uifer Systems of the United States. Papers present-ed at AWRA Symposium on Monitoring, Model-ing, and Mediating Water Quality, May 17-20, 1987, Syracuse, New York. AWRA Monograph Series No. 11, 1988. p 37-61, 7 fig, 3 tab, 28 ref.

Descriptors: \*Geohydrology, \*Glacial aquifers, \*Groundwater budget, \*Groundwater recharge, \*Groundwater resources, \*Regional Aquifer-Systems Analysis, \*Surface-groundwater relations, Aquifers, Hydrologic budget, Infiltration, Runoff, Snow, Snowmelt.

Estimates of the volume of water available annually or monthly for recharge to sand and gravel aquifers in the glaciated Northeast are needed for aquifer modeling and assessment of potential aquifer yield. Sources of recharge include direct infliration of precipitation on the aquifers, runoff from till-covered upland hillsides bordering the aquifers, and seepage from streams. The volume of water available annually for recharge is generally equal to annual runoff (precipitation minus evapotranspiration). This quantity ranges from 12 to 30 inches over most of the glaciated Northeast. Quantities of water available for recharge from direct infiltration can be estimated by applying the water balance equation to data presented in this paper, to routinely published data on precipitation, snow-pack, and temperature, and to evapotranspiration data computed from pan evaporation or various formulas. Quantities available are greatest during November, December, March, and April and generally equal or approach zero from June through September. Quantities may exceed 6 inches per month at higher elevations and latitudes during periods of snowmelt. Quantities of water available monthly for recharge from upland hillslopes and from tributary streams where they cross valley-fill aquifers can be estimated from rates of runoff in upland areas. The Northeast can be divided into six regions, each with a distinctive monthly runoff pattern that is controlled largely by winter snow ly or monthly for recharge to sand and gravel aquifers in the glaciated Northeast are needed for

### Group 2F-Groundwater

accumulation and spring snowmelt. (See also W91-02280) (Author's abstract) W91-02283

EVALUATION OF THE CONTINUOUS SEIS-MIC-REFLECTION METHOD FOR DETER-MINING THE THICKNESS AND LITHOLOGY OF STRATIFIED DRIFT IN THE GLACIATED

Geological Survey, Hartford, CT. Water Re-For primary bibliographic entry see Field 7B. W91-02284 ources Div.

CONTINUOUS SEISMIC-REFLECTION PRO-FILING OF GLACIAL DRIFT ALONG THE SUSQUEHANNA, CHEMUNG, AND CHEN-ANGO RIVERS, SOUTH-CENTRAL NEW YORK AND NORTH-CENTRAL PENNSYLVA-

Geological Survey, Albany, NY. Water Resources

For primary bibliographic entry see Field 7B. W91-02285

GEOCHEMISTRY OF THE STRATIFIED-DRIFT AQUIFER IN KILLBUCK CREEK VALLEY WEST OF WOOSTER, OHIO.

Geological Survey, Columbus, OH. Water Resources Div. K. J. Breen.

K. J. Breen.
Ih: The Northeast Glacial Aquifers. Regional Aquifer Systems of the United States. Papers presented at AWRA Symposium on Monitoring, Modeling, and Mediating Water Quality, May 17-20, 1987, Syracuse, New York. AWRA Monograph Series No. 11, 1988. p 105-131, 12 fig, 2 tab, 22 ref.

Descriptors: \*Geochemistry, \*Geohydrology, \*Glacial aquifers, \*Groundwater quality, \*Groundwater resources, \*Killbuck Creek Valley, \*Regional Aquifer-Systems Analysis, \*Stratified drift, \*Water chemistry, Aquifers, Chlorides, Glacial drift, Groundwater chemistry, Iron, Manga-

Water for Wooster, Ohio, is obtained from two well fields developed in the stratified glacial drift of the Killbuck Creek valley. A contamination incident in 1983 closed the city's southern well field and caused increased pumping stress on the aquifer near the remaining well field. As a result, water levels in production wells dropped to record low levels in 1984-85. A geochemical study of groundwater was conducted during this period to evaluate the processes affecting water chemistry. Results indicate that the composition of water produced from the well field is controlled, in part, by the mineralogy of the water-yielding zones and by the mineralogy of the water-yielding zones and by mixing of water in the drift aquifer with water from the underlying sandstone and shale bedrock. A mixing and mass balance analysis based on A mixing and mass balance analysis based on sodium and chloride indicates that water from the production well at the center of the well field is about 80% drift water and 20% bedrock water. The percentage of drift water ranges from < 10% at the easternmost production well to > 90% at the westernmost production well. The aquifer matrix is comprised mostly of quartz with calcite, dolomite, illite, and iron-chlorite. Groundwater chemistry and the presence of sericitized feldspar, kaolinite, and minerals containing oxidized iron indicate that groundwaters are involved in carbonoxygen reactions, dissolution and precipitation of carbonate minerals, hydrolysis of silicates, and iron and manganese reactions. These mixing and chemiand manganese reactions. These mixing and chemi-cal processes produce an iron-rich, sodium calcium cal processes produce an iron-rich, sodium calcium chloride bicarbonate-type water at the central and easternmost production wells. The two westernmost production well waters and the deep drift waters, in general, are an iron-rich, calcium bicarbonate type. (See also W91-02280) (Author's abstract) stract) W91-02286

USE OF OXYGEN-18 AND DEUTERIUM MASS-BALANCE ANALYSIS TO EVALUATE INDUCED RECHARGE TO STRATIFIED-DRIFT AQUIFERS.

Geological Survey, Albany, NY. Water Resources

J. E. Dysart J. E. Dysart.

IN: The Northeast Glacial Aquifers. Regional Aquifer Systems of the United States. Papers presented at AWRA Symposium on Monitoring, Modeling, and Mediating Water Quality, May 17-20, 1987, Syracuse, New York. AWRA Monograph Series No. 11, 1988. p 133-154, 13 fig, 2 tab, 15 ref.

Descriptors: \*Aquifers, \*Deuterium, \*Geohydrology, \*Glacial aquifers, \*Glacial drift, \*Groundwater recharge, \*Groundwater resources, \*Mass balance, \*Oxygen isotopes, \*Regional Aquifer-Systems Analysis, \*Stratified drift, \*Surface-groundwater relations, Geochemistry, Hydraulic conductivity, Hydrogen isotopes, Infiltration, New Jersey, Ohio, Recharge.

The environmental isotopes oxygen-18 and deuterium have been used to distinguish between the native groundwater in stratified drift aquifers and stream water that may infiltrate and recharge those stream water that may inflitrate and rectange those aquifers, commonly as a result of large groundwater withdrawals that lower the water table near streams. In the glaciated northeastern United States, the seasonal variation in the values of these States, the seasonal variation in the values of these isotopes in aquifers is much smaller than in river water. Where groundwater beneath or near a stream consistently has the same isotope values as the stream, infiltration is indicated. Water samples from deep and shallow wells in stratified drift, from bedrock wells, and from streams were collected near municipal well fields in Ohio and New Jersey and analyzed for deuterium, oxygen-18, tritium, and dissolved constituents. The isotope values of water from the pumped wells were compared num, and dissolved constituents. In elsotope values of water from the pumped wells were compared with those of streams and native groundwater to: (1) estimate the percentage of pumped water that was derived by infiltration from the river; (2) calwas derived by inititation from the river; (2) cau-culate, in conjunction with head measurements, the hydraulic conductivity of the streambed; and (3) evaluate seepage from bedrock into the stratified drift. Infiltration rates calculated from deuterium and oxygen-18 data were in general agreement with those calculated from stream loss measurewith those calculated from stream loss measurements. Induced stream infiltration at the New Jersey site was computed to be about 1.4 cu ft/sec with a range of 2.5 to 0.7 cu ft/sec, and streambed hydraulic conductivity was calculated to be about 1.6 ft/day. Induced infiltration at the Ohio site was determined to be negligible, but tributary streams and upward leakage of bedrock water contribute water to the stratified drift aquifer. (See also W91-02280) (Author's abstract) W91-02287

STATE-OF-THE-ART OF HYDROLOGY AND HYDROGEOLOGY IN THE ARID AND SEMI-ARID AREAS OF AFRICA.

For primary bibliographic entry see Field 2A.

CONTRIBUTION OF CIEH IN THE FIELD OF HYDROGEOLOGY (CONTRIBUTION DU CIEH DANS LE SECTEUR DE L'HYDROLO-GIE).

Comite Interafricain d'Etudes Hydrauliques, Ouagadougou (Burkina Faso). Dept. of Hydrology. For primary bibliographic entry see Field 2A. W91-02294

NATURAL GROUNDWATER RECHARGE ES-TIMATION IN (SEMI-)ARID ZONES: SOME STATE-OF-THE-ART OBSERVATIONS. Vrije Univ., Amsterdam (Netherlands). Inst. voor

Aardwetenschappen.

1. Simmers.
I. Simmers.
Ih: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 373-386, 2 fig, 18 ref.

Descriptors: \*Arid lands, \*Groundwater recharge, \*Recharge, \*Semiarid lands, Analytical methods, Developing countries, Estimating, Hydrologic

Current international developments relating to natural and 'man-induced' groundwater recharge indicate a number of problems, including the lack of a comprehensive estimation technique, lack of knowledge about the areal extent of any derived recharge results, and limited applicability of data from any given site and extreme variability in data quantity and quality. With these ideas as a framework, specific topics are discussed, including: definitions (aridity, groundwater recharge) ground. quantity and quality. With these ideas as a framework, specific topics are discussed, including: definitions (aridity, groundwater recharge), groundwater recharge processes, temporal and spatial variability of recharge, resource management implications, and recharge requirements for groundwater modeling. The final choice of techniques for estimating groundwater recharge will depend on study objectives, initial data base and the possibility of supplementing the data base, and available financial resources. Although recharge mechanisms are reasonably well known, deficiencies are evident in quantifying the various elements. Under arid conditions recharge is intermittent and concentrated in small areas; these characteristics make point methods preferable to areal methods for estimation of recharge. Issues relating to spatial and temporal variability and result regionalization create a series of problems for which further investigation is needed. When data are inadequate, as is often the case in developing countries, a flexible approach to project design can be employed to collect data as resource development proceeds. Conceptual hydrological models are important in this process. (See also W91-02288) (Rochester-PTT) W91-02318

WATER TRANSFER IN POROUS NON-SATURATED ROCK AND AQUIFER RECHARGE IN THE SUDANO-SAHELIAN CLIMATE (TRANSFERT D'EAU EN MILIEU POREUX NON SATURE RECHARGE DES NAPPES EN CLIMAT SOUDANO-SAHELIEN).

Ecole Inter-Etats d'Ingenieurs de l'Equipement Rural, Ouagadougou (Burkina Faso).

Rural, Ouagadougou (Durkina s and Julyin). The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 387-396, 3 fig, 1 tab, 12 ref. English

Descriptors: \*Africa, \*Aquifers, \*Arid lands, \*Evaporation, \*Groundwater recharge, \*Hydro-logic budget, \*Sahel, \*Sudan, Estimating, Groundwater management, Performance evaluation, Rainfall-runoff relationships, Recharge, Soil moisture

In the Sudano-Sahelian region of Africa, the utilization of groundwater resources is of primary importance. For optimal management, their capacity must be known, particularly for renewal processes. With regard to recharge of the aquifers, one of the greatest difficulties in the Sudano-Sahelian climate is associated with the effects of evaporation. Generally, recharge is estimated through the difference of the terms of the hydrologic balance (precipitation, evaporation, and runoff). However, veryoften the evaporation that constitutes the principal element of this balance is being estimated inexactly with the result that the recharge amount derived from it is even less accurate. The inaccuracy is partially due to the estimation of the usable reserve in the soil, which generally is assumed to equal the quantity of water stored in the first soil layers (often more than 1 m), whereas field experience shows that evaporation affects even greater depths. Therefore, there is a risk that in certain cases the calculation of recharge leads to over-estimations, which would result in an over-exploitation of aquifers. (See also W91-02288) (Author's abstract) W91-02319 In the Sudano-Sahelian region of Africa, the utili-W91-02319

INVESTIGATION OF GROUNDWATER RE-CHARGE MECHANISMS IN BURKINA FASO. Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen. J. van Brussel, W. Geirnaert, I. Simmers, and J. J.

### Groundwater-Group 2F

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 397-405, 4 fig, 11 ref.

Descriptors: \*Arid lands, \*Burkina Faso, \*Groundwater recharge, \*Hydrologic budget, \*Recharge, \*Tracers, Aeration zone, Chlorides, Isotopic tracers, Network design, Performance evaluation, Rainfall, Tritium, Water chemistry.

Chloride and tritium methods were employed in a study of recharge in northwest Burkina Faso. Two recharge mechanisms are active in the thick, weathered mantle covered crystalline basement complex in Burkina Faso: (1) diffuse recharge and (2) localized recharge via preferential pathways. Due to the low chloride content in precipitation a chloride balance cannot be used to determine re-Due to the low chorder content in precipitation a chloride balance cannot be used to determine re-charge. However, the absence of significant chlo-ride accumulation in the upper soil indicates that the diffuse mechanism is taking place. The distribu-tion of tritium concentrations in the unsaturated tion of tritium concentrations in the unsaturated zone and in the groundwater indicates that a 'rapid' recharge component also is present. The relative importance of both recharge mechanisms can be obtained only through a combined approach of unsaturated zone and groundwater studies. Large-scale sampling of precipitation chemistry is necessary to obtain representative results. (See also W91-02288) (Rochester-PTT)

EXPLORATION OF KARSTIFIED JOINTS IN PRECAMBRIAN LIMESTONE AQUIFERS OF THE GONDO PLAIN (MALI) WITH ELECTRO-MAGNETIC HORIZONTAL-LOOP METHODS (LOCALISATION DES FRACTURES KARSTI-GOCALISATION DES FRACTURES KARSTI-FIEES DES CALCAIRES PRECAMBBRIENS DANS LA PLAINE DU GONDO (MALI) PAR LA PROSPECTION ELECTROMAGNETIQUE BIPOLE).

Neuchatel Univ. (Switzerland). Center of Hydrolo-

gy.
I. Muller, and G. Bieler.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 406-415, 7 fig, 10 ref. English sum-

Descriptors: \*Aquifer testing, \*Aquifers, \*Data acquisition, \*Geophysical studies, \*Groundwater level, \*Groundwater mining, \*Mali, \*Rock properties, \*Wells, Gondo Plain, Irma formation, Karst hydrology, Limestone, Measuring instruments, Performance evaluation.

In the Gondo Plain (Mali) the groundwater level is sinking regularly because of the poor rainfall distribution of the past few years. More and more wells are put down in the limestones of the Irma formation, which is overlain by 40-50 m of silt-clay deposits of the 'Continental Terminal.' For the location of productive fissures, several geophysical methods were tested in terms of accuracy. Many productive and dry wells were investigated using original prototype instruments. Low frequency (0.4 and 4 Hz) geoelectric, very low frequency (12-25 kHz) resistivity (VLF-R), and electromagnetic bipole instruments were compared. Geoelectrical methods were not the best suited to locate small heterogeneities at greater depth hidden by thick conductive overburden. The depth penetration with the VLF-R also was very limited. The electromagnetic bipole seems to be the best tool to get out the sharpest contrast on the karstified joints. Horizontal-loop profiling (Slingram method) with typical coil separation of 80 m at 2048 hz was well adapted to realize anomaly maps. These maps make clear that all productive wells are located in those zones where the quadrature values (percent of out-phase) are negative. Dry wells are always situated in the positive zones of the maps. Multidirectional electromagnetic vertical soundings indicate the degree of anisotropic contrast depending on depth and permit the strike and intensity of the regional joint development to be found. One of the

most important advantages of the inductive elec-tromagnetic exploration in arid zones is the speed of data acquisition, because the coils work without soil contact. (See also W91-02288) (Author's abstract) W91-02321

ELECTRIC METHOD IN VILLAGE HYDRAU-LIC PROJECTS IN BENIN: THE CASE OF CRYSTALLINE FORMATIONS (GRANITE-SANDSTONE) (LA METHODE ELECTRIQUE EN HYDRAULIQUE VILLAGEOISE: CAS DES FORMATIONS CRISTALLINES (GRANITE-CONDESSE) GNEISS))

Universite Nationale du Benin, Cotonou. Dept. de

Universite Nationate du Belain, Colonia de Physique.
R. Darboux-Afouda.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 416-424, 3 fig, 6 ref. English summa-

Descriptors: \*Aquifer testing, \*Aquifers, \*Geo-physical studies, \*Groundwater mining, \*Rural areas, \*Wells, \*West Africa, Conductivity, Geo-logic fractures, Gneiss, Granites, Pumps, Resistivi-

In the last few years, some hydrological projects in crystalline formations of West African countries have consisted of supplying villages with drilled wells and pumps. In these areas, economic aquifers usually occur in fissured and fractured zones. To detect such zones in the field, resistivity profiling has been used for a long time: the zones are identified as conductive compartments on resistivity profiles. However, the reverse is not always true. The studies suggest that the best qualitative interpretations can be obtained by using both Schlumberger and square arrays for horizontal profiling. Fracture zones are then identified as a combination of low apparent resistivity and low apparent anisotropy. This methodology, which is well adapted to crystalline formations (granite-gneiss) with thin weathered layers, could indicate accurately the locations of productive wells when applied to a village hydrology project in Benin. Both theoretical and empirical studies support the view that this method is well-adapted to studies of aquifers with fractures and fissures in granite-gneiss. (See also W91-02288) (Author's abstract)

HYDROGEOLOGICAL AND GEOPHYSICAL ELECTROMAGNETIC STUDY OF THE ALLUVIAL AQUIFER OF WADI TELOUA, AGADEZ, NIGER (ETUDE HYDROGEOLOGIQUE ET GEOPHYSIQUE ELECTROMAGNETIQUE DE LA NAPPE ALLUVIALE DU KORI TELOUA, AGADEZ, NIGER).

Institut Universitaire d'Etudes du Developpement, Acadez (Niger).

Agadez (Niger). F. Balmer.

F. Balmer.

In: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 425-434, 6 fig, 1 tab, 6 ref. English

Descriptors: \*Alluvial aquifers, \*Aquifer characteristics, \*Aquifers, \*Geohydrology, \*Groundwater level, \*Niger, \*Sahel, \*Water resources devel-Agricultural water, Alluvial deposits, Groundwater movement, Groundwater recharge, Piezometers, Resistivity, Tracers, Urbanization,

In the Air Massif, in Niger's Sahelian region, the local population farms principally in the valleys. Increased use of water for agriculture and insufficient recharge due to poor rainfall over the past 15 cient recharge due to poor rainfall over the past 15 yr, are leading to a serious imbalance. Water requirements for agricultural self-sufficiency are no longer assured and even domestic use is becoming a problem. Situated on the piedmont of the Air Massif, the alluvial aquifer of the wadi, which

supplies Agadez (population 45,000) and its agri-cultural zone, the Teloua, has undergone a drop of 10 m over the last 5 yr. The volume of water penetrating the aquifer during the annual floods no longer compensates for natural loss and use of water in the zone. Most wells are dry despite efforts to deepen them. The alluvial deposits com-prising the assertion; are sessentially composed of efforts to deepen them. The alluvial deposits com-prising the reservoir are essentially composed of more or less muddy sands and weathered rocks. These deposits block the sedimentary channels at the Air's edges as well as its ancient granitic val-leys. In an effort to define the geological and hydrogeological structures of the aquifer and its recharge area and the path and speed of flow, piezometric, geophysical, and multitracing studies were carried out. Paleochannels comprise most of the aquifer and its zone of recharge. (See also W91-02288) (Author's abstract) W91-02323

PROSPECTING FOR AQUIFER FRACTURES IN THE CRYSTALLINE BASEMENT BY SOIL RADON ANALYSIS (PROSPECTION DES FRACTURES AQUIFERES DU SOCLE CRISTALLIN PAR DOSAGE DU GAZ RADON CONTENU DANS LE SOL).

Bureau de Recherches Geologiques et Minieres,

Bureau de Recherches Geologiques et Minneres, Orleans (France).
R. Mathieu, S. Puyoo, and M. Ricolvi.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Iliinois. 1990. p 435-447, 4 fig, append. English sum-

Descriptors: \*Aquifers, \*Burkina Faso, \*Geologic fractures, \*Geophysical surveys, \*Groundwater resources, \*Isotopic tracers, \*Radon, \*Tracers, Lithology, \*Performance evaluation, Well data, Well

thology, Performance evaluation, Well data, Well yield.

The emanation of radon gas through the ground in areas with an igneous or metamorphic basement increases with fracturing of the underlying rock and with its water content. Radon prospecting has been used to complement photointerpretation and electrical geophysics in the search for wells with a yield greater than 5 cu m/hr at three sites in Burkina Faso with differing hydrogeological and climatic conditions. At Sanon there are about ten high-contrast to very high-contrast anomalies (up to 4480 pcic/l) despite a 20-50 m clay cover on a basement of migmatites and granites. The wells with the highest yield correspond to the strongest and most extensive radon anomalies and, with one exception, the intersect highly fractured zone. At Katchari the background noise is weak (125 pCi/l) although the sandy clay saprolites of the ampibolitic basement are only of average thickness (14-22 m). The anomalies, not of high contrast, are aligned along the conductive zones revealed by electrical geophysics. The highest yields corresponded to the strongest emanations. Barogo has a varied substratum (schist, diorite, tuff, etc.) situated under 10-40 m of clayey saprolite. The variations in the fairly low level of background noise (average 190 mCi/l) in places mark the lithological changes in the basement. Only one high-contrast anomaly (890 pCi/l) was discovered in a zone with a fairly high background noise (280 pCi/l) despite 32 m of saprolite. The well sunk there yields 25 cu m/hr, the highest yield on this sile. Although radon prospecting used as a supplement to conventional methods has yielded very positive results, many questions remain to be answered. (See also W91-02288) (Author's abstract) W91-02324

GEOPHYSICAL PROSPECTING GROUND WATER EXPLORATION IN DIS-CONTINUOUS AQUIFERS FOR RURAI WATER SUPPLY PROJECTS IN THE SAHEL

C.M. Consulting and Management, Rome (Italy).
C. Rossi, and R. Zoppis.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouaga-

### Group 2F-Groundwater

dougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 448-455, 1 tab, 8 ref.

Descriptors: \*Aquifers, \*Geophysical exploration, \*Groundwater resources, \*Mali, \*Sahel, Cost analysis, Data interpretation, Discontinuous aquifers, Economic aspects, Performance evaluation, Resistivity, Rural areas, Wells.

Geophysical prospecting for groundwater explora-Geophysical prospecting for groundwater explora-tion for rural water supply projects in areas of the Sahel, where the aquifer is discontinuous, can no be considered indispensable for obtaining results capable of justifying the cost. This prospecting, which must be preceded by detailed photogeologi-cal studies, is based essentially on geoelectric meth-ods, in particular electrical vertical soundings and ods, in particular electrical vertical soundings and resistivity profiles, sometimes associated with magnetic profiles. Geophysical prospecting was conducted in the Republic of Mali to establish the best location for 466 productive wells in 279 villages as part of a project funded by the Italian Technical Cooperation Agency. The large quantity of geophysical and hydrogeological data available made it possible to define both the optimal methods of prospecting and the best interpretation of the findings for the different geologic formations, which are representative of the major discontinuous aquifers in the Sahel. It is concluded that, if the methods are employed carefully and use extreme precision both in the measurements and locating the resistivity anomalies on the ground, geophysical prospecting can give excellent results. In fact, cal prospecting can give excellent results. In fact, the cost of geophysical prospecting as a percentage of the total cost of a drilled well (3-4% on average) of the total cost of a drilled well (3-4% on average) is amply covered by the greater success (up to more than 20%) that can be obtained compared to research based entirely on photointerpretation. (See also W91-02288) (Rochester-PTT)

NEW INSTRUMENTS FOR ELECTRICAL AND AUDIOMAGNETOTELLURIC PROSPECTING (CARACTERISTIQUES DES EQUIPEMENTS MODERNES DE PROSPECTION GEOPHYSI-QUE PAR METHODS ELECTRIQUE OU AU-DIOMAGNETOTELLURIOUE).

Bureau de Recherches Geologiques et Minieres, Orleans (France). For primary bibliographic entry see Field 7B. W91-02326

GEOPHYSICAL RECONNAISSANCE IN A FIS-SURED STRUCTURE: EXAMPLE IN LIP-TAKO, REP. NIGER (RECONNAISSANCE GEOPHYSIQUE EN MILIEU FISSURE: EXEM-PLE AU LIPTAKO, REP. NIGER).

Niamey Univ. (Niger).

B. Ousmane, J. C. Lachaud, and P. Therme. B. Ousmane, J. C. Lachaud, and P. Therme.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 468-479, 6 fig. English summary.

Descriptors: \*Data acquisition, \*Geophysical exploration, "Groundwater prospecting, "Niger, An-isotropy, Borehole geophysics, Data processing, Geohydrology, Geologic fractures, Liptako, Per-formance evaluation, Remote sensing.

Measurements using electrical prospecting or physical methods are influenced by the stratification of the terrain, faults, and diaclases. Consequently, arrangements for the orientation of measurements are rangements for the orientation of measurements are important. Numerous experiments and studies have been carried out in the field of electrical prospecting using a multidirectional investigation method. The aim of this technique is to bring into agreement the electrical anisotropy of the rock and the fracturing as determined by aerial photos, satellite imagery, or hydrogeological studies. By combining classical methods (electrical, geophysical) with multidrectional investigations (squares, double rectangle), a methodology has been developed to help hydrogeologists set boreholes in difficult structures. Tests conducted at 10 sites in Liptako (Niger) demonstrated the capability of the method to produce good results in the hands of a compe-

tent operator. Results from three of the sites are described in detail as examples. (See also W91-02289 (Rochester-PTT) W91-02327

GEOPHYSICAL METHODOLOGY APPLIED TO RURAL WATER SUPPLY IN BEDROCK ENVIRONMENT: PRELIMINARY RESULTS (METHODOLOGIE GEOPHYSIQUE APPLI-QUEE A L'HYDRAULIQUE VILLAGEOISE EN ZONE DE SOCLE: RESULTATS PRELIMIN-AIDES)

Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. de Geophysique.

zerland). Inst. de Geophysique.
V. T. Angelillo.
IN: The State-of-the-Art of Hydrology and Hydrology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 480-490, 5 fig, 5 ref. English summa-

Descriptors: \*Aquifers, \*Geophysical exploration, \*Groundwater resources, \*Measuring instruments, \*Niger, \*Sahel, \*Subsurface mapping, Bedrock, Drilling, Geologic fractures, Rural areas, Water level, Well yield.

Many studies and surveys have demonstrated how useful geophysics can be in groundwater prospecting. In the case of fractured aquifers, the rural water supply projects of the development programs in Sahelian countries have carried out several routine surveys in the bedrock zones to locate water-bearing fractures. Generally only one method was used. Improvements in results can be obtained by appropriate combining of geophysical obtained by appropriate combining of geophysical methods. The study area was northeast of Zinder methods. Ine study area was northeast of Zinder (Niger) in Precambrian granites. During the 1987-1988 drilling campaign, geophysical prospecting was conducted by combining very low frequency (VLF) mapping with classical electrical profiling and sounding. VLF filtered data (tilt angle and and sounding. VLF intered data (till angier and quadrature measurements) were used to obtain, on the field, two different maps of the faulted area allowing for the deduction of direction and relative depth of fractionation. On favorable anomalies, a depth of fractionation. On favorable anomalies, a restricted geophysical survey could then locate the drilling site with greater accuracy. This approach improved the percentage of positive drillings, as well as the average well yield. In addition, placing the pumps on the deepest structures insures that installations will last longer as piezometric level declines continuously. (See also W91-02288) declines continuously. (Rochester-PTT) W91-02328

AQUIFER CHARACTERISTICS IN THE SEDI-MENTARY BASINS OF THE SEMI-ARID AND ARID AREAS OF KENYA. Nairobi Univ. (Kenya). Dept. of Geology.

Nairobi Univ. (Renya). Dept. of Geology.
G. O. Krhoda.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 491-501, 6 tab, 15 ref.

Descriptors: \*Aquifers, \*Geohydrology, \*Ground-water resources, \*Kenya, \*Semiarid lands, Arid lands, Lithology, Regional analysis, Sedimentary

Finding and developing sources of groundwater is becoming an increasingly urgent need in many parts of Kenya. This is particularly critical in arid and semi-arid lands, which form nearly two thirds of the total area of the country. Groundwater sources were investigated in the sedimentary basins of eastern Kenya with the aim of determining aquifer characteristics. Although data are fragmentary and patchy, it is possible to identify three types of aquifers in the area in terms of both depth and lithology. There are shallow aquifers (3-10 m deep), deep aquifers (35-40 m), and deep and fractured aquifers. According to lithology, the first type of aquifer is composed of unconsolidated or poorly consolidated sand and gravel commonly interbedded with clay. The second type consists of

semi-consolidated and consolidated conglomerate, semi-consolidated and consolidated congiomerate, sandstone, or shale formations with joints or frac-tures. The third type of aquifer is in limestone and gypsum beds and generally contains saline water. Further research is needed to make clear the extent of each type of aquifer and to determine the quan-tity and quality of water in each. (See also W91-02288) (Author's abstract) W91-02329

HYDRAULIC PROPERTIES OF FOUR SOILS IN NIGER AND IMPLICATIONS FOR WATER BALANCE STUDIES.

International Crops Research Inst. for the Semi-Arid Tropics, Niamey (Niger). For primary bibliographic entry see Field 2G. W91-02330

STUDY OF GROUNDWATER RESOURCES OF THE BUBAQUE AND BOLAMA ISLANDS (BISSAGOS ISLANDS) (ETUDE DES RES-SOURCES EN EAU SOUTERRAINE DES ILES DE BUBAQUE ET BOLAMA (ARCHIPEL DES BIJAGOS)).

Direction Generale des Ressources Hydriques, Bissau (Portuguese Guinea).

M. S. Diallo.

M. S. Diatto.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 513-523, 5 ref. English summary.

Descriptors: \*Aquifer characteristics, \*Geohydrology, \*Groundwater recharge, \*Groundwater resources, \*Guinea-Bissau, \*Islands, Bolama Island, Bubaque Island, Groundwater level, Long-term studies, Statistics.

A program of studies and hydrogeological re-A program of studies and hydrogeological research on exploitation was conducted in Guinea-Bissau, concerning the exploitation of fresh water on the islands of Bubaque and Bolama. Prospecting and hydrogeological investigations yielded an inventory of water points, levels, geophysical data, piezometric data, and boreholes. Sixty-two years of pluviometric data and piezometric measurements from 20 study programs were analyzed with the aid of a combined rain-water level model. Calibration of the model made it possible to establish the elements of the hydrologic balance for a period of 62 yr, particularly recharge data. The study shows that the recharge is greater on Bolama (200 mm) than on Bubaque (mean value 130 mm). study shows that the recharge is greater on Bolama (200 mm) than on Bubaque (mean value 130 mm). A frequency analysis of the annual recharge shows that the data follow a the Gaussian distribution curve with a coefficient of about 17%, which is evidence for a small variability in yearly values. Dry decade values are on the order of 150-200 mm for Bolama and 90 mm for Bubaque. Since 1982, the annual recharge values show a systematic deficit with an exceptionally low value in 1984 after a dry period of 30 yr. (See also W91-02288) (Author's abstract) W91-023131 W91-02331

GROUNDWATER RESOURCES IN A POORLY TRANSMISSIVE SANDSTONE IN A SEMI-ARID ENVIRONMENT: 1. ESTIMATION OF

RECHARGE.
Sveriges Geologiska A.B., Goeteborg (Sweden).
L. Carlsson, J. Bromley, and J. Smellie.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 524-539, 7 fig. 1 tab, 14 ref.

Descriptors: \*Botswana, \*Geohydrology, \*Groundwater recharge, \*Groundwater resources, \*Kalahari Desert, \*Recharge, \*Sandstones, \*Semi-arid lands, Aquifers, Geochemistry, Hydrologic models, Model studies, Rainfall penetration, Recipied and the studies of the stu

The eastern extremity of the Kalahari Desert thirstland (Botswana) is semi-arid, with a mean

### Groundwater-Group 2F

annual rainfall of 447 mm, most of which falls erratically between October and April. However, there is little or no surface runoff because the water is rapidly absorbed by the thick sand mantle of this region. Recharge in a semi-arid area on the fringe of the Kalahari Desert thirstland in Botswaor tims tegion. Accharge in a semi-aria area on the fringe of the Kalahari Desert thirstland in Botswana was calculated using various methods. Recharge to a sandstone aquifer concealed by Kalahari sand was found to be small and limited to the eastern escarpment of the Kalahari plateau. Geochemical and isotopic data supported active recharge, which was quantified by hydrometeorological calculations, numerical aquifer flow modeling, and chloride balance calculations. Initial soil moisture studies were used to study the recharge process. Based on these results, it is suggested that rainfall concentration might permit the retention capacity of the sand to be overcome, thus permitting some limited recharge. Longer-term and more detailed work is needed to confirm this view. (See also W91-02288, W91-02333, and W91-02334) (Rochester-PTT) W91-02332

GROUNDWATER RESOURCES IN A POORLY TRANSMISSIVE SANDSTONE IN A SEMI-ARID ENVIRONMENT: 2, REGIONAL INVESTIGATION OF GEOLOGICAL STRUCTURES. Sveriges Geologiska A.B., Lulea (Sweden). For primary bibliographic entry see Field 7B.

GROUNDWATER RESOURCES IN A POORLY TRANSMISSIVE SANDSTONE IN A SEMI-ARID ENVIRONMENT: 3. ESTIMATION OF RESOURCES.

RESOURCES.
Sveriges Geologiska A.B., Goeteborg (Sweden).
L. Carlsson, J. Bromley, and B. Mannstrom.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 549-561, 6 fig. 13 ref.

Descriptors: \*Aquifer characteristics, \*Botswana, \*Geohydrology, \*Groundwater recharge, \*Groundwater resources, \*Sandstones, \*Semiarid lands, Drawdown, Geological fractures, Groundwater level, Hydraulic properties, Kalahari Desert, Pumping tests, Regional analysis, Water level, Wells.

Wells.

The Ntane (formerly Cave) sandstone aquifer (eastern Botswana) is in the Kalahari Desert, a semi-arid region where mean annual rainfall is a little more than one third of potential evapotranspiration. Hydraulic testing in this poorly transmissive sandstone was performed by long-term pumping tests. Delayed yield influenced the drawdown in more than 40 days of pumping in an unconfined condition. The groundwater resource in the area was calculated as a function of well spacing and aquifer transmissivity for siting both in fracture zones identified and in the naturally fissured sandstone. The results of the resource calculation show that a required resource of 35,000 cu m/day is available for 25 yr from the 1700 sq km of confined Ntane aquifer. On a regular grid basis, 175 wells covering 350 sq km would be required. The renewable resource of the whole study area, provided irregularly by intermittent recharge, is estimated to be 8,000 cu m/day. After abstraction for 25 yr, the groundwater level theoretically will have been lowered about 40 m when no recharge is considered. (See also W91-02288, W91-02332, and W91-02334) (Rochester-PTT) ered. (See also W91-022 02333) (Rochester-PTT)

IMPROVED YIELD OF RURAL WORKS THROUGH HYDRAULIC FRACTUR-ING EXPERIMENTS (AMELIORATION DE LA PRODUCTIVITE DES OUVRAGES D'HY-DRAULIQUE VILLAGEOISE PAR FRACTURA-TION HYDRAULIQUE EXPERIMENTATION). Bureau de Recherches Geologiques et Minieres, Orleans (France). Water Resources Dept. For primary bibliographic entry see Field 4B. W91-02335 GROUNDWATER QUALITY IN RURAL AREAS IN WESTERN AFRICA.
International Bank for Reconstruction and Devel-

opment, Abidjan (Ivory Coast). Regional Water and Sanitation Group.

and Sanitation Group.
O. Langenegger.
In: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 574-584, 8 fig. 3 tab, 13 ref.

Descriptors: \*Africa, \*Geochemistry, \*Geohydrology, \*Groundwater pollution, \*Groundwater quality, \*Rural areas, \*Water chemistry, \*Water pollution sources, \*Water quality, Burkina Faso, Chemical properties, Conductivity, Ghana, Hydrogen ion concentration, Ivory Coast, Mali, Niger, Organic wastes, Physicochemical properties, Pumps, Regional analysis, Turbidity, Wells.

Pumps, Regional analysis, Turbidity, Wells.

The physicochemical composition of groundwater plays an important role not only because of its health impact but in terms of user acceptance, and affects technical aspects (eg, corrosion) as well as industrial and agricultural applications. A general overview of groundwater quality in western Africa is given based mainly on field trials of the World Bank-executed INT/81/026 Handpumps Project, which covered Burkina Faso, Ivory Coast, Ghana, Mali, and Niger, on the 3000 Well Drilling Program in Ghana, and the Helvetas Project in Mali. Physical parameters considered include temperature, pH, electrical conductivity, and turbidity. Chemical constituents investigated were iron, manganese, oxygen, carbon dioxide, ammonium, nitrite, and nitrate. The groundwater occurring in the Handpumps Project area is, in general, of good quality, with a low level of dissolved minerals, which is typical for non-carbonate formations that underlie much of the investigated areas. The predominance of 'acidic' rocks is the major cause of aggressive groundwater. Organic wastes in and aggressive groundwater. Organic wastes in and around settlements are the single most important source of groundwater pollution in the rural envi-ronment. Livestock concentrations around water ronment. Livestock concentrations around water sources and dirtiness and inadequate drainage of water also cause groundwater pollution. Well pollution is caused by inadequate well construction or defective wells, poorly installed or defective handpumps, and inadequately designed handpumps and handpump corrosion. (See also W91-02288) (Author's abstract) W91-02336

CORROSIVITY PROBLEMS IN RURAL WATER SUPPLY PROJECTS IN SAHELIAN AREAS OF WEST AFRICA.

AREAS OF WEST AFRICA.
C.M. Consulting and Management, Rome (Italy).
L. Zoppis, and R. Zoppis.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 585-589, 11 ref.

Descriptors: \*Corrosion, \*Geochemistry, \*Groundwater quality, \*Mali, \*Sahel, \*Water chemistry, \*Wells, Geohydrology, Performance evaluation, Rural areas, Testing procedures, West

The problem of corrosive groundwaters in drilled wells has recently become a serious concern throughout the Sahelian areas of West Africa. A throughout the Sahelian areas of West Africa. A preliminary assessment of corrosion was conducted in the Mali Rural Water Supply Project. An investigation method was devised that permits the prior evaluation of the corrosive potential of groundwater in a relatively quick and cheap way, in line with the needs and possibilities of most village water supply projects. The proposed methodology takes into account the parameters that best identify the corrosive nature of groundwaters where iron is a factor, namely, the 'Langelier Index' and 'Tillaman's Diagram.' These parameters can be used to conduct an initial evaluation of the water from each well. To assess the groundwaters of a given region, two steps are required: (1) collect and utilize all chemical analysis data concerning

groundwaters tapped by existing wells in the project area and (2) perform physical and chemical analyses using rapid spectrophotometric and volumetric methods on the groundwater of each drilled well, with the sample being taken prior to pump installation. The data obtained can be used to calculate the two indexes. Results obtained from a sample of 150 wells in Mali showed that the method was generally adequate for evaluating groundwater corrosivity and for predicting its future development. (See also W91-02288) (Rochester-PTT) W91-02337

VULNERABILITY OF THE BRAZZAVILLE VULNERABILITY OF THE BRAZZAVILLE
AQUIFER AND THE RISK OF CONTAMINATION WITH DOMESTIC WASTES (PROBLEMES DE VULNERABILITE DE LA NAPPE
DE BRAZZAVILLE ET RISQUES DE CONTAMINATION PAR LES REJETS DOMESTI-

Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Brazzaville (Congo). Centre ORSTOM de Brazzaville. For primary bibliographic entry see Field 5B. W91-02339

HYDROGEOLOGICAL ROLE OF THE FAULTS IN THE VALLEYS OF THE SOUTH OF AIR (REPUBLIC OF NIGER) (SUR LES ROLES HYDROGEOLOGIQUES DES FAILLES DANS LES VALLEES DU SUD D'AIR (REPUBLICHE) NICERD. LIQUE DU NIGERI).

Ministere des Ressources, Animales et de l'Hydraulique, Niamey (Niger).

A. K. Dodo.

A. K. Dodo.
In: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 636-647, 8 fig, 1 ref. English summa-

Descriptors: \*Aquifers, \*Geohydrology, \*Geologic fractures, \*Groundwater movement, \*Groundwater recharge, \*Niger, Groundwater resources, Pumping tests, Saline water, Tectonics, Water

Short-duration pumping tests in the Awagadi valley (some 30 km north of Agadez (Niger) demonstrated that the fault was feeding the alluvial aquifer in the valley. This fault had been identified previously through photogeological studies of the catchment. Statistical studies and an analysis of fracturing showed that the direction of the fault corresponds perfectly to the delineation of the tectonics of the region. Investigation of the water chemistry in the northern part of the study area indicates the presence of saline water intrusion (conductivity: 2,000 microS/cm; pH: 8.12; Na(+): 410 mg/L; Cl(-): 360 mg/L; SO4(-): 160 mg/L). This hypermineralization is very probably the effect of another system from which water is also flowing through the faults. (See also W91-02288) (Author's abstract)

INFLUENCE OF CONTINENTAL RIFTING ON THE HYDROGEOLOGY OF THE BAHI DRAINAGE BASIN, DODOMA PROVINCE, CENTRAL TANZANIA.

Cooperative Inst. for Research in Environmental Science, Boulder, CO. Center for the Study of Earth from Space. J. C. Brock, and R. F. Arenz

J. C. Brock, and R. F. Arenz.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illipoir 1900, 649,650 10 cef. nois. 1990. p 648-659, 10 ref.

Descriptors: \*Geohydrology, \*Groundwater movement, \*Groundwater resources, \*Remote sensing, \*Satellite technology, \*Tanzania, \*Tec-tonics, Bahi Swamp, Chenene Hills, Rifts, Vegeta-

### Group 2F-Groundwater

The control of rift-associated geologic structuring on the surficial and groundwater flow patterns of the Bash Drainage Basin on the southern extent of the East Africa Rift (Tanzania) was investigated. Landsat multispectral scanner (MSS) image data were used to infer the presence of rift-associated regional faulting. A Landsat MSS scene was digitally processed to enhance the depiction of structure. turally controlled geomorphology and hydrogeo-logic features. Image processing procedures ap-plied to all four MSS spectral bands included geo-metric rectification to a Universal Transverse Mercator map projection and contrast enhancement by linear stretch operations. The interpretations of linear faults and fracture trends was enhanced by linear streich operations. The interpretations of linear faults and fracture trends was enhanced by the spatial frequency filtering of all four bands followed by the generation of band composite images. Vegetation index images were generated using a linear combination of MSS bands. The resultant images supported the interpretation of possible groundwater recharge areas and active stream channels. The distribution of potential alluvial aquifers and the drainage pattern was inferred from false-color composite images derived from the contrast-enhanced MSS bands and high pass directional spatial frequency filtered images. The Chenene Hills occupy the south-central portion of the study area, Bahi Swamp is situated to the southwest and Dodoma City lies at the southern limit of the study area. A major northeast-southwest trending fault zone extending from the northern Bahi Swamp and passing immediately to the north of the Chenene Hills was mapped based on Landsat MSS image data and previous geologic field investigations. It is proposed that this fault trend has disturbed a pre-existing northwest-south-central ending drainage system and caused the southwestward diversion of both surface and groundwater flow into the Bahi Drainage Basin. This may have results in the formation of the Bahi Swamp in a closed topographic depression west of the Chenene Hills. Accordingly, the regional Ints may have results in the formation of the Bain Swamp in a closed topographic depression west of the Chenene Hills. Accordingly, the regional northeast-southwest striking fault trends to the northeast of the Bahi Swamp are recommended for groundwater exploration. (See also W91-02288)

STUDY OF PIEZOMETRIC DEPRESSIONS BY ENVIRONMENTAL ISOTOPES: FIRST DATA ON EXAMPLES IN MALI (ETUDE DES DE-PRESSIONS PIEZOMETRIQUES PAR LES ISOTOPES DE L'ENVIRONNEMENT: PRE-MIERES DONNEES SUR DES EXEMPLES AU MALD.

MALI).
Projet AIEA, Dakar (Senegal).
J. F. Aranyossy, and A. Guerre.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 660-670, 5 fig, 1 tab, 25 ref.

Descriptors: \*Groundwater movement, \*Ground-water recharge, \*Isotopic tracers, \*Mali, \*Piezo-metric head, \*Tracers, Carbon isotopes, Evapora-tion, Groundwater resources, Interior Delta, Mathematical models, Nara Region, Simulation, Triti-

An environmental study on the piezometric de-pressions of the 'Nara' region (northwest Mail) and 'Interior Delta' (central part) led to two conclu-sions. First, the absence of a logical distribution of radioactive water content (tritium and 14C) from the margin toward the center of the depressions demonstrates predominance of vertical movement over lateral water transfers; the seasonal recharge over lateral water transfers; the seasonal recharge of the phreatic aquifer does not appear to be followed by regional circulation. Second, the clear relationship between isotopic enrichment and water table depth corresponds to the flushing of heavy isotopes accumulated in the unsaturated zone during the dry season. The evaporation flux, estimated at about 500 mm/yr at 1 m depth, decreases exponentially with depth (1 mm/yr at 15 m.). These values, when employed in a mathematical simulation model gave a satisfactory fit between observed and calculated isopiezes. Considering that no recharge occurs in the central part of the basin, this evaporation flux would be sufficient

to create and maintain piezometric depressions. (See also W91-02288) (Author's abstract) W91-02343

TURBULENT FLOW THEORY FOR AFRICAN RECOLITHS

Utah International, Inc., San Francisco, CA.

Otan International, Inc., San Francisco, CA.

N. Krishnamurthi.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Il-linois. 1990. p 672-685, 3 fig, 3 tab, 1 ref, append.

Descriptors: \*Africa, \*Groundwater movement, \*Mathematical models, \*Model studies, \*Regoliths, \*Sahel, \*Turbulent flow, \*Well yield, Aquifers, Geologic fractures, Groundwater recharge, Laminar flow.

Current groundwater flow theories are applicable to aquifers of granular materials. The conventional to aquifers of granular materials. The conventional concepts of transmissivity, storage coefficient, and cone of depression may fail to explain turbulence that can be witnessed in a dug well in hard rocks. A fresh approach is needed to model the flow and the well yield in hard rocks like the African regoliths. A turbulent flow model was developed for simulating the flow in African regolithic aquifers. Three assumptions were made in developing the model: (1) flow into a well is through small conduits through the inner surface of the well; (2) water travels from a distance R (assumed constant) from the well, and (3) the portarity depth of the water travels from a distance R (assumed constant) from the well; and (3) the operative depth of the well is reckoned below the static water level and there is no flow into the well above this static water level. Equations describing this model are developed in detail and well function and flow conductance, pumping test and analysis, and lamiar inflow theory for hard rock open wells are discussed in detail. The model in its current form is cutted for field testing in the Sahelian region beascussed in detail. The model in its current form is suited for field testing in the Sahelian region be-cause of the recharge potential there. (See also W91-02288) (Rochester-PTT) W91-02344

SOLUTION OF DISSEMINATED CALCITE IN QUARTZ VEINS OF BIRRIMIEN SCHISTS IN BURKINA FASO AS A KEY TO A POSSIBLE

BURKINA FASU AS A KEY TO A PUSSIBLE AQUIFER MODEL.
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
W. Geirnaert, P. Bloemen, W. Kool, and J. J. van

der Sommen.

In: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 701-710, 6 fig, 6 ref.

Descriptors: \*Aquifer characteristics, \*Burkina Faso, \*Calcite, \*Geochemistry, \*Geohydrology, \*Hydrologic models, \*Water chemistry, Clays, Miscopy, Quartz, Schist

Borings conducted in Birrimien volcano-sedimen-tary schists (Burkina Faso) show solution features within quartz veins. Microscopic study of thin sections revealed the presence of calcite, interminsections revealed the presence of calcite, intermingled with the quartz and generally recrystallized, forming an integral part of the lithological unit. Comparison of hydrochemical data from grantite and schist aquifers shows that calcite solution is mainly active in schistose rocks and occurring on a regional scale. Clayey weathering products and a more plastic deformation, a result of stress, make the currently adopted geologic model for grantite aquifers ('valley fill' model) non-applicable to schistose rocks. The calcite solution process is of major importance in developing an acceptable hydrogeological model for schist aquifers. (See also W91-02288) (Author's abstract) W91-02346

USE OF PERSONAL COMPUTERS FOR THE ANALYSIS AND MANAGEMENT OF HYDRO-METEOROLOGICAL AND GROUNDWATER

Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 7C.

ARRIVAL OF A GENERATION OF FIELD EXPERT SYSTEMS (L'AVENEMENT D'UNE GENERATION DE SYSTEMES EXPERTES DE TERRAIN).

ILOG S.A., Gentilly (France). For primary bibliographic entry see Field 7C. W91-02354

STATE OF THE ART HYDROLOGY FOR THE DEVELOPMENT OF SAHELIAN WATER RE-

Ohio Univ., Athens. Dept. of Hydrogeology. M. U. Ahmad.

M. U. Anmao.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 812-823, 5 fig, 18 ref.

Descriptors: \*Africa, \*Agricultural water, \*Groundwater mining, \*Groundwater resources, \*Hydrologic models, \*Sahel, \*Water resources development, Arid lands, Data acquisition, Design criteria, Developing countries, Geohydrology, Libya, Monitoring, Sahara, Satellite technology, Semiarid lands, Wells.

There is great controversy among meteorologists and ecologists about the causes of the persistent Sahelian drought. In all development planning for the Sahel, high levels of climatic variability and inevitable drought are accepted as 'normal.' Sahelian countries can benefit by knowledge of deep aquifers in the Libyan Sahara. The Kufra Production Project (KPP), Kufra Settlement Project (KSP), and the Sarir Production Project (SPP) have been operating for over 15 yr. Systematic monitoring data coupled with two-dimensional and three-dimensional modeling provide unique hydrological insight into the extraction of water for large-scale projects, such as the Great Man Made River Project. Based on experience from these large-scale projects, such as the Great Man Made River Project. Based on experience from these Libyan projects, a plan is presented for development of groundwater resources for agriculture in the Sahelian countries. The magnitude of such development does not depend on knowing the water budget but does depend on the degree of hydrological effects that can be tolerated at a given time. A plan for study would include the following eight steps: (1) use satellite-derived data for basic geological and hydrogeological information; (2) conduct general geologic reconnaissance; (4) pumptest exploration and production wells for 5-day to 10-day periods to determine preliminary aquifer parameters and water quality; (5) construct a numerical identification model using all the collected data; (6) use the model and other tools (e.g., geologic maps, aerial photos, geophysical logs) to logic maps, aerial photos, geophysical logs locate well fields in areas with soils suitable growing crops; (7) employ a modern well design for high performance production; and (8) use data from the well fields to update the original three-dimensional model every year. (See also W91-02288) (Rochester-PTT) W91-02355

INTEGRATED APPROACH FOR THE EVAL-UATION OF GROUNDWATER RESOURCES: A CASE STUDY IN YATENGA (APPROCHE IN-TEGREE POUR L'EVALUATION DES RES-SOURCES EN EAU SOUTERRAINES: ETUDE DE CAS AU YATENGA). Ministry of Water Resources, Ouagadougou (Bur-

kina Faso).

B. Wedraogo, P. Bloemen, and B. Diagana. B. Wedradgo, r. Bloemen, and B. Duagan.
IN: The State-of-the-Art of Hydrology and Hydrogology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 824-835, 5 fig. 11 ref. English sumDescriptors: \*Burkina Faso, \*Groundwater re-charge, \*Groundwater resources, \*Rural areas, \*Water supply development, \*Wells, Aerial pho-tography, Geohydrology, Groundwater move-ment, Infiltration, Isotopic tracers, Pumping tests, Water supply, Well yield.

Ongoing village water supply drilling programs and detailed hydrogeological field studies (comprising core drillings, long-duration pumping tests, hydrochemical and isotope analyses, etc.) have been combined to study the basic characteristics and the recharge of aquifer systems of the crystaline shield in Yatenga Province, northwest Burkina Faso. The characteristics of the aquifers appear to be determined primarily by the lithology of the underlying bedrock. On granitic rock, the fractured zone is in continuous hydraulic contact with the overlying weathered zone and they react tured zone is in continuous hydraulic contact with the overlying weathered zone and they react during pumping tests as one hydrologic medium. On schistose rock, a remarkable difference in permeability exists between the clayey alterites and the fractured bedrock. Hydrochemical and isotope analyses show that recharge by diffuse infiltration is limited (40-140 mm/yr) and slow (less than 0.3 m/yr) and a non-negligible part of the recharge takes place as rapid drainage via preferential paths (localized recharge). Interpretation of aerial photos and geophysical investigations show that the best drilling locations for village water supply programs are situated on the coincidence of major structural lineaments and the lower part of the erosional glacis. (See also W91-02288) (Author's abstract) abstract) W91-02356

GROUNDWATER MONITORING: VOLATILE ORGANIC CHEMICALS BENEATH UNSEWERED SUBDIVISION.

Wisconsin Univ.-Eau Claire. Dept. of Geology. For primary bibliographic entry see Field 5B. W91-02413

HYDROLOGICAL ASPECTS OF THE DEVEL-OPMENT AND RAPID DECAY OF THE 1989

Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 2B. W91-02428

SUBCLINICAL EFFECTS OF GROUNDWATER CONTAMINANTS. II. ALTERATION OF RE-GIONAL BRAIN MONOAMINE NEURO-TRANSMITTERS BY BENZENE IN CD-1

Utah State Univ., Logan. Dept. of Biology. For primary bibliographic entry see Field 5C. W91-02469

GEOPHYSICAL INVESTIGATION-SOUTH-WESTERN GREAT ARTESIAN BASIN. For primary bibliographic entry see Field 8E. W91-02529

SUPERCOMPUTERS AND THEIR USE IN MODELING SUBSURFACE SOLUTE TRANS-PORT.

Western Australia Univ., Nedlands. Centre for Water Research.
For primary bibliographic entry see Field 7C.
W91-02543

INTEGRATED APPROACH TO QUANTIFY GROUNDWATER TRANSPORT OF PHOS-PHORUS TO NARROW LAKE, ALBERTA. Alberta Univ., Edmonton. Dept. of Zoology. R. D. Shaw, J. F. H. Shaw, H. Fricker, and E. E.

Limnology and Oceanography LIOCAH, Vol. 35, No. 4, p 870-886, June 1990. 7 fig, 5 tab, 46 ref.

Descriptors: \*Alberta, \*Groundwater movement, \*Lakes, \*Limnology, \*Narrow Lake, \*Nutrients, \*Phosphorus, Darcys equation, Mathematical models, Piezometry, Seepage.

An integrated approach was used to quantify groundwater phosphorous flux to Narrow Lake, a

small glacial terrain lake in central Alberta. Data from a drilling program, major ion concentrations, environmental isotopes, and computer simulations indicated that the lake gains water through the nearshore region, from a small shallow groundwater flow system, at deep offshore regions, water moves from the lake to the groundwater flow system. Seepage flux was quantified by water budget, Darcy's equation with data from wells near the lake, Darcy's equation with data from minipiezometer in the lake, and seepage meters. Whole lake seepage flux determined from minipiezometer data (30 mm/yr) was only 10-25% of the other estimates (mean, 221 mm/yr; range, 133-332 mm/yr from seepage meter and water budget data, respectively). Groundwater contributed 30% of the annual water load to the lake. The P concentration in pore water from lake sediments (mean, 175 mg cum) was 8 times higher than groundwater from wells near the lake (mean, 21 mg m cu). Thus, if well water was used to estimate P concentrations of the seepage water, the rate of groundsmall glacial terrain lake in central Alberta. Data trations of the seepage water, the rate of ground-water P loading to the lake would be underestimat-ed. The rate of groundwater P loading to the lake eu. Ine rate of groundwater P foating to the lake computed from average seepage flux and average pore water P concentration was 39 mg sq m/yr, and groundwater may be the largest single source of P to epilimnetic water in the lake. (Author's abstract) W91-02589

GROUNDWATER RECHARGE FROM LAKE

CHAD. Indiana Univ.-Purdue Univ. at Fort Wayne. Dept. of Earth and Space Sciences. S. A. Isiorho, and G. Matisoff. Limnology and Oceanography LIOCAH, Vol. 35, No. 4, p 931-938, June 1990. 5 fig. 1 tab, 28 ref. NSF Grant Int 83-19271.

Descriptors: \*Groundwater recharge, \*Lake Chad, \*Limnology, \*Salinity, \*Salt balance, \*Surfacegroundwater relations, \*Water chemistry, Africa, Aquifers, Flow rates, Groundwater movement, Piezometry, Seepage, Water table.

The open waters of Lake Chad are reasonably free of salt (120-320 mg/L) even though it is a shallow, old, closed-basin lake located in the highly evarities environment of sub-Saharan Africa. It is possible that the lake remains relatively fresh due to the significant removal of water and solutes by to the significant removal of water and solutes by seepage into the groundwater beneath the lake. Directly measured seepage rates (seepage meters and core tracer methods) through the sandy lake bottom are 0.00115 m/d. The regional water table derived in this study indicates the lake to be at a higher hydraulic elevation than the phreatic aquice between the contract of the contraction of the contract of the cont fer hydraulic elevation, and measurements of the groundwater flow direction determined from minigroundwater now direction determined from mini-piezometric nests confirm that flow is SW, away from the lake. Preliminary calculations indicate that seepage plays a significant role in water and solute budgets, since it removes as much as 18% of the annual water input and 40-160% of the annual salt input to the lake. (Author's abstract) W91-02591

WATER RESOURCES FOR FLORIDA, WATER YEAR 1989, VOLUME 2A. SOUTH FLORIDA -SURFACE WATER.

Geological Survey, Miami, FL. Water Resources For primary bibliographic entry see Field 7C. W91-02625

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1989, VOLUME 2B. SOUTH FLORIDA - GROUND WATER. Geological Survey, Miami, FL. Water Resources

For primary bibliographic entry see Field 7C. W91-02626

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1989, VOLUME 3A: SOUTH-WEST FLORIDA SURFACE WATER. Geological Survey, Tampa, FL. Water Resources

For primary bibliographic entry see Field 7C. W91-02627

WATER RESOURCES FOR CALIFORNIA, WATER YEAR 1989, VOLUME 4: NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.

Geological Survey, Sacramento, CA. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02628

WATER RESOURCES DATA FOR MASSACHU-SETTS AND RHODE ISLAND, WATER YEAR

Geological Survey, Boston, MA. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02629

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1989.

Geological Survey, Rolla, MO. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02630

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1989.

Geological Survey, Helena, MT. Water Resources Div For primary bibliographic entry see Field 7C. W91-02631

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1989, VOLUME 1: AT-LANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.

Geological Survey, West Trenton, NJ. Water Re-For primary bibliographic entry see Field 7C. W91-02632

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1989, VOLUME 2: DELAWARE RIVER BASIN AND TRIBUTAR-1ES TO DELAWARE BAY.

Geological Survey, West Trenton, NJ. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02633

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1989, VOLUME 2: LONG IST AND

Geological Survey, Syosset, NY. Water Resources For primary bibliographic entry see Field 7C. W91-02634

WATER RESOURCES DATA FOR PENNSYL-VANIA, WATER YEAR 1989. VOLUME 2: SUS-QUEHANNA AND POTOMAC RIVER BASINS. Geological Survey, Harrisburg, PA. Water Re-sources Div. For primary bibliographic entry see Field 7C. W91-02635

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1989.

Geological Survey, San Juan, PR. Water Resources Div. For primary bibliographic entry see Field 7C. W91-02636

WATER RESOURCES DATA FOR SOUTH CAROLINA, WATER YEAR 1989. Geological Survey, Columbia, SC. Water Resources Div.

For primary bibliographic entry see Field 7C.

### Group 2F-Groundwater

W91-02637

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1989.
Geological Survey, Huron, SD. Water Resources

For primary bibliographic entry see Field 7C W91-02638

TON, WATER YEAR 1989, Geological Survey, Tacoma, WA. Water Resources Div.

For primary bibliographic entry see Field 7C. W91-02641

INSTALLATION OF A MULTIPORT GROUND-WATER SAMPLING SYSTEM IN

THE 300 AREA.
Battelle Pacific Northwest Labs., Richland, WA. For primary bibliographic entry see Field 5A. W91-02670

GROUNDWATER MANAGEMENT: QUANTITY AND QUALITY.

For primary bibliographic entry see Field 4B. W91-02672

EVALUATION OF HYDROGEOLOGICAL PARAMETERS IN HETEROGENEOUS POROUS

MEDIA.

Ecole Nationale Superieure des Mines de Paris,
Fontainebleau (France). Centre d'Information

Fontamebleau (France). Centre d'anomaisses Geologique.
P. Lachassagne, E. Ledoux, and G. deMarsily.
IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 3-18, 6 fig, 23 ref.

Descriptors: \*Aquifer characteristics, \*Aquifer testing, \*Geohydrology, \*Groundwater management, \*Model studies, \*Transmissivity, \*Water resources management, Decision making, Heterogeneity, Injection, Numerical analysis, Parametric hydrology, Permeability, Porous media, Pumping tests, Slug tests, Soil porosity.

For most hydrogeological problems, and particu-larly in heterogeneous porous media, the global permeability (or transmissivity) of the aquifers is the most important parameter to be determined for the most important parameter to be determined for long-term predictions. In practice, the most common methods used by hydrogeologists to de-termine these parameters consist in radial pumping or injection tests. Two approaches can thus be considered: (1) performing numerous short dura-tion tests and then to calculate from these local values a global estimation of the transmissivity; and (2) performing long-term pumping tests where the value of the effective transmissivity is obtained directly by classical methods of interpretation. The results of the two approaches for the estimation of the global transmissivity were compared by means of numerical simulations. The slug test or injection test over a small section of a well or piezometer when performed at numerous locations is suitable to determine both the type of distribution and the to determine both the type of distribution and the variogram of the local permeability values. Long-term pumping tests can be used as a means to validate the averages which could be obtained from local measurements. The mean transmissivity value established from such a test is identical to the one derived by averaging results from local tests. one derived by averaging results from local tests. Thus both methods seem to lead to similar results. Long-term pumping tests are indeed very costly, and do not provide sufficient information on the variability of the system unless a large number of piezometers is available. (See also W91-02672)

SOME ASPECTS OF SOIL MOISTURE CONTROL FOR SOILS WITH SHALLOW GROUNDWATER LEVELS.

Agricultural Univ. of Warsaw (Poland). Dept. of

For primary bibliographic entry see Field 2G. W91-02674 Land Reclamation

ACCESS OF SMALL AND MARGINAL FARM-ERS TO GROUNDWATER-A FIELD STUDY, Roorkee Univ. (India). Water Resources Development Training Center.
For primary bibliographic entry see Field 4B. W91-02675

INDICATOR CONDITIONAL SIMULATION OF THE ARCHITECTURE OF HYDRAULIC CONDUCTIVITY FIELDS: APPLICATION TO A SAND-SHALE SEQUENCE.
Stanford Univ., CA. Dept. of Applied Earth Sci-

J. J. Gomez-Hernandez.

J. J. Comez-Hernandez.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 41-51, 6 fig, 9 ref.

Descriptors: \*Aquifer characteristics, \*Geohydrology, \*Model studies, \*Oil fields, Algorithms, California, Hydraulic conductivity, Numerical analysis, Oil shale, Parametric hydrology, Sand aquifers, Stochastic models, Structural geology, Uncertain-

A prior requirement to the use of a numerical model is the assignment of aquifer parameter values to the blocks of the model. Data available values to the blocks of the model. Data available are few, sparse, and typically vary in space in a way that cannot be deterministically reproduced. This variability introduces uncertainty in the predicted parameter values, which will be responsible for uncertainty in the final response of the model. A new algorithm for stochastic conditional simula-A new algorithm for stochastic conditional simula-tions has been used to generate images of the Wilmington oil field (Los Angeles, California, basin) sand-shale sequence. The range of the vari-able under study was subdivided into mutually exclusive classes and an indicator was associated with each class. Indicator covariances were used to characterize the random geometric pattern be-tween classes. These indicator covariances can be used to include structural qualitative information, such as the expected amount of random shales or the expected geometric continuity of any given class or rock type. When there are not enough data to infer precisely all indicator covariances a sensitrivity analysis can be performed and a visual selec-tion among images generated using different covar-iance models can help in the selection of the cor-rect covariance model. Such selection amounts to the use of implicit geological information/interpre-tation in the covariance modeling. (See also W91-02672) (Author's abstract) (Fish-PTT)

DISTRIBUTION OF AQUIFER RECHARGE FROM A CIRCULAR SPREADING BASIN UNDER TRANSIENT OPERATIONS.

Colorado State Univ., Fort Collins. Dept. of Civil Engineering.

For primary bibliographic entry see Field 4B.

ESTIMATION OF THE TRANSMISSIVITY OF THE SANTIAGO AQUIFER, CHILE, USING DIFFERENT GEOSTATISTICAL METHODS. Pontificia Univ. Catolica de Chile. Santiago. Fac-

ulty of Engineering.

J. F. Munoz-Pardo, and R. Garcia.

J. F. Munoz-rardo, and R. Oarcia.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 77-84, 1 fig. 3 tab, 7 ref.

Descriptors: \*Aquifer characteristics, \*Geostatistics, \*Groundwater management, \*Groundwater movement, \*Kriging, \*Model studies, \*Statistical methods, \*Transmissivity, \*Water resources management, Chile, Data interpretation, Linear programming, Regression analysis, Specific capacity.

Deterministic numerical models simulating the be-havior of groundwater are useful tools in the evaluation, planning, and management stages of this resource. More sophisticated and elaborate models resource. More sophisticated and elaborate models are continuously being proposed. However, the information available is usually limited and subject to large sampling and interpretative errors. To overcome these difficulties, it then becomes necessary to introduce into these models the effects of quality, quantity, and spatial distribution of the input data. Three geostatistical methods to estimate the transmissipity of an ouifer using the informainput data. Three geostatistical methods to estimate the transmissivity of an aquifer using the information commonly available were developed: simple kriging, kriging combined with linear regression, and co-kriging. A comparison was performed between the accuracy of the estimations. In a study of the Santiago aquifer, Chile, it was observed that kriging combined with linear regression gave better estimates, by taking into account the additional information contained in the specific capacity values, which greatly improves the estimation of the transmissivity of an aquifer. (See also W91-02672) (Fish-PTT)

OUTLIERS IN GROUNDWATER QUALITY TIME SERIES.

Polish Academy of Sciences, Warsaw. Inst. of Geophysics. For primary bibliographic entry see Field 7C. W91-02687

THREAT TO GROUNDWATER QUALITY BY PESTICIDES IN THE NETHERLANDS.

Rijksinstituut voor de Volksgezondheid, Bilthoven (Netherlands). For primary bibliographic entry see Field 5B. W91-02688

HYDROGEOLOGY AND WATER CHEMISTRY IN THE WEATHERED CRYSTALLINE ROCKS OF SOUTHWESTERN NIGERIA.

Loughborough Univ. of Technology (England). Dept. of Civil Engineering. A. Owoade, L. G. Hutton, W. S. Moffat, and M. D. Bako.

D. Dako.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 201-214, 7 fig, 3 tab, 19 ref.

Descriptors: \*Geochemistry, \*Geochydrology, \*Geophysical surveys, \*Groundwater quality, \*Nigeria, \*Water chemistry, Crystalline rocks, Groundwater management, Groundwater reharge, Kaolinite, Permeability, Porosity, Recharge, Resistivity, Water demand, Water quality management, Water resources management, Weathering zone, Wells.

The groundwater potential in crystalline rock terrains depends on post-emplacement processes such as tectonism and weathering which could lead to the development of secondary porosity and permeability. Geophysical and hydrochemical techniques have been used to assess the groundwater prospects in the crystalline weathered regolith in southwestern Nigeria. The resistivity measurements gave an average depth of weathering of 34 m. From a consideration of the hydrodynamics of the weathering process, kaolinite was found to be the stable clay weathering product indicating that weathering reaction products are being flushed since otherwise feldspar-water equilibrium would have been attained considering the Pre-Cambrian age of the rocks. The presence of kaolinite was The groundwater potential in crystalline rock terhave been attained considering the Pre-Cambrian age of the rocks. The presence of kaolinite was taken to imply that the groundwater is being recharged but it was not possible to use the available data to quantify the recharge. Analysis of recovery observations on one of the large diameter wells sampled gave an average permeability of 50 mm/h (1.2 m/day). These results indicate that the weathered regolith in the study area could support modest water demands. Some rethinking may be necessary regarding generalizations in the literature vis-a-vis the groundwater potential in hard rock terrains. (See also W91-02672) (Author's abstract) W91-02691

CHARACTERIZING THE HYDROGEOLOGI-CAL VARIABILITY OF A SAND AQUIFER IN THE REGION OF A DOMESTIC WASTE DIS-POSAL SITE

Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.

For primary bibliographic entry see Field 5B. W91-02692

DECOMPOSITION AND ELIMINATION OF TYPICAL POLLUTANTS FROM SANITARY LANDFILLS IN POROUS AQUIFERS,

Technische Univ. Braunschweig (Germany, F.R.). Leichtweiss-Inst. fuer Wasserbau und Grundbau. For primary bibliographic entry see Field 5B. W91-02693

COUPLING OF CHEMISTRY AND TRANS-

PORT.
Gesamthochschule Kassel (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W91-02694

IDENTIFICATION OF UNSATURATED SOLUTE TRANSPORT PARAMETERS.
Pontificia Univ. Catolica de Chile, Santiago. Faculty of Engineering.
For primary bibliographic entry see Field 5B.
W91-02695

INTERACTIVE GROUNDWATER MODEL-LING: COLOUR GRAPHICS, ICAD AND AI. International Inst. for Applied Systems Analysis, Laxenburg (Austria).

Laxenburg (Austria).

K. Fedra, and H. J. Diersch.

IN: Groundwater Management: Quantity and
Quality. Proceedings of the Symposium held at
Benidorm, Spain, October 2-9, 1989. International
Association of Hydrological Sciences, Washington, DC. 1989. p 305-320, 4 fig, 6 ref.

Descriptors: \*Artificial intelligence, \*Computer models, \*Finite element method, \*Graphical analysis, \*Hydrologic models, \*Mapping, \*Model studies, Geohydrology, Graphical methods, Groundwater management, Groundwater movement, Groundwater pollution, Parametric hydrology, Water quality management, Water resources management, water resources management, water resources management, water resources management.

An interactive groundwater modeling system, based on a two-dimensional finite element simulator, has been developed. Combining a finite element model for flow and transport problems with an artificial intelligence (AI)-based and symbolic graphics user interface, the system is designed to allow the easy and efficient use of complex groundwater modeling technology in a problem-oriented rather than model-oriented style. Implemented on a color-graphics engineering workstation, the system provides a problem manager that allows the selection of site-specific, as well as generic, groundwater problems from problem libraries, or the interactive design of a new problem. These problems can be edited and modified and then simulated under interactive user control. The system also features an extensive Intelligent Comthen simulated under interactive user control. The system also features an extensive Intelligent Computer Aided Design (ICAD) component that allows the user to design very efficiently, and parametrize, a new problem from the very beginning, using a map or an auxiliary grid as a background for the definition of problem geometry and hydrogeological parameters. (See also W91-02672) (Author's abstract)

INTEGRATED FINITE DIFFERENCE MODEL FOR GROUNDWATER FLOW AND QUALITY SIMULATION.

Bologna Univ. (Italy). Facolta di Ingegneria.

M. Ferraresi.

M. Ferraresi.
IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International

Association of Hydrological Sciences, Washington, DC. 1989. p 321-330, 5 fig, 9 ref. National Public Education Ministry of Italy grant MPI 8903002

Descriptors: \*Finite difference methods, \*Ground-water movement, \*Groundwater quality, \*Hydro-logic models, \*Model studies, \*Path of pollutants, Aquifer characteristics, Geohydrology, Ground-water management, Mathematical analysis, Porous media, Water quality management, Water re-

Although the integrated finite difference method represents a powerful numerical technique for solving problems of groundwater flow in porous media, scan attention has been paid to its application to real world geohydrological studies. An integrated finite difference model for groundwater flow and quality simulation has been developed. It can deal with multidimensional, multilayered, hetrogeneous, anisotropic media, both in confined and phreatic conditions. Its mathematical structure combines the advantages of an integral formulaand phreatic conditions. Its mathematical structure combines the advantages of an integral formulation, which allows complex geometry problems to be solved more easily than by classical finite difference methods, with the simplicity of gradient evaluation, which can be regarded as an advantage over finite element techniques. Comparison with analytical and numerical results does not offer argument for rejecting the choice of the integrated finite difference approach, while the operational activities needed for the input preparation and the model calibration seem more expeditious when this methodology is applied. (See also W91-02672) (Author's abstract) thor's abstract) W91-02700

LOCALIZED ADJOINT METHODS: APPLICA-TION TO ADVECTION DOMINATED FLOWS. Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Geofisica. I. Herrera.

I. Herrera.
I.N: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 349-357, 10 ref.

Descriptors: \*Advection, \*Groundwater, \*Hydrologic models, \*Mathematical models, \*Model studies, \*Path of pollutants, Algorithms, Boundary conditions, Probability distribution, Water quality management, Water resources management, Water

The numerical solution of the advective-diffusive The numerical solution of the advective-diffusive transport equation is a problem of great importance because many problems in science and engineering involve such a mathematical model. Solution of advection-dominated transport problems by discrete interior methods is usually accomplished by employing some type of upstream weighting. Upwinded finite element formulations have also been constructed. At present a new perceduse is by employing some type of upstream weighting. Upwinded finite element formulations have also been constructed. At present, a new procedure is being developed, based on Herrera's algebraic theory of boundary value problems, which systematically uses localized adjoint formulas. For one-dimensional steady state problems the procedure yielded very efficient and highly accurate algorithms which compare favorably with those previously available. For time-dependent one-dimensional cases the two algorithms applied corresponded to using two different weighting functions. Two test problems were treated to evaluate the performance of the new method: the propagation of a step discontinuity and that of a Gaussian distribution. The results and the efficiency of the procedure were compared with other methods, testing the effect of changing several parameters. The conclusion was reached that the solutions obtained with this method are at least as good as those obtained using the best available interior methods. Similar conclusions were drawn for two-dimensional problems, in general, localized adjoint methods allow very effective treatment of boundary conditions, but this is especially evident for two-dimensional problems, as a result of their greater difficulty. (See also W91-02672) (Fish-PTT)

TARGET LEVEL GROUNDWATER MANAGEMENT MODEL WITH LINEARIZED FLOW AND TRANSPORT CONSTRAINTS.

Commonwealth Scientific and Industrial Research Organization, Wembley (Australia), Div. of Water

S. A. Prathanar.

S. A. Pratnapar.

In: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 369-380, 6 fig. 2 tab, 4 ref.

Descriptors: \*Groundwater management, \*Groundwater pollu-tion, \*Hydrologic models, \*Model studies, \*Path of pollutants, \*Solute transport, \*Water quality of pollutants, \*Solute transport, \*Water quality management, \*Water resources management, Australia, Optimization, Potentiometric level, Simulation analysis, Water table fluctuations, Water table

Simulation and optimization models are usually Simulation and optimization models are usually combined to determine groundwater management strategies, because it is unlikely that optimal groundwater management alternatives which comply with groundwater hydraulics could be determined by either simulation or optimization models alone. A two-dimensional groundwater management model with linearized flow and transport constraints was developed to determine stresses required to lower a water table to target levels. The linearized Boussinezq equation is em-bedded as the initial solute transport constraint, assuming constant potentiometric gradients. In addition, a mass balance equation for solutes is embedded to account for changes in concentration due to changes in potentiometric heads. Girgarre, Victoria, Australia was selected as the study area. Strategies determined by the management model with and without solute transport constraints were verified by a two-dimensional solute transport sim-ulation model. Assumptions made with regard to solute transport constraints were satisfactory when concentration gradients were gradual. Smaller time steps will be required to determine stresses for management of aquifers where steeper concentration gradients exist. (See also W91-02672) (Fish-PTT) W91-02704

MODELING OF VARIABLE DENSITY FLOW, APPLICATION TO THE MANAGEMENT OF COASTAL AQUIFERS (MODELISATION DES ECOULEMENTS A DENSITE VARIABLE, AP-PLICATION A L'EXPLOITATION DES AQUI-FERES COTIERS).

Bureau de Recherches Geologiques et Minieres, Orleans (France).

J. P. Sauty.

J. P. Sauty.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sociences, Washington, DC. 1989. p 393-404, 6 fig. 12 ref. (English

Descriptors: \*Coastal aquifers, \*Flow models, \*Groundwater management, \*Groundwater move-ment, \*Hydrologic models, \*Model studies, \*Saline water intrusion, \*Water quality management, "Water resources management, Density stratification, Finite difference methods, Flow equations, Saline-freshwater interfaces, Seawater, Simulation analysis, Three-dimensional model.

The modeling of variable-density flow in aquifers is useful for many applications. The production of fresh water from coastal aquifers partially invaded by seawater is a particular case of high concern for the management of maritime provinces. The use of models is necessary for understanding the phenomena, predicting the impact of new installations and optimizing freshwater production while keeping control of the inland progression of the salt water interface. Usual modeling techniques simplify the problem to a two-dimensional scheme (horizontal plane or vertical cross-section); unfortunately the modeling of real cases often requires a full three-modeling of real cases often requires a full threemodeling of real cases often requires a full three-dimensional approach. A simulation technique based on a particle tracking method is proposed;

### Field 2-WATER CYCLE

### Group 2F-Groundwater

the density of the particle population determines the local volume mass of the fluid. The vertical the local volume mass of the fluid. The vertical density gradients simply yield source terms in the equation for flow, which is solved by finite differ-ences, in terms of water pressure. The resulting code (named TED for Transport with Effect of code (named 1ED for Transport with Effect of Density) is checked against two solutions: (1) the position of the salt water wedge close to the coast, and (2) the coning caused by drainage of fresh water above an initially horizontal interface. (See also W91-02672) (Author's abstract) W91-02706

OPTIMAL GROUNDWATER QUALITY MAN-AGEMENT UNDER UNCERTAINTY: INCOR-PORATING THE EFFECTS OF SPATIAL VARI-ABILITY OF HYDRAULIC CONDUCTIVITY. Stanford Univ., CA. Dept. of Applied Earth Sci-

For primary bibliographic entry see Field 5G. W91-02708

GRAVEL EXTRACTION AND WATER RE-SOURCES MANAGEMENT OF THE DENGE GRAVEL AQUIFER, KENT, ENGLAND. Aspinwall and Co., Shrewsbury (England). For primary bibliographic entry see Field 4C. W91-02723

GROUNDWATER FLOW AND QUALITY STUDIES IN SZIGETKOZ REGION, NORTH-WEST HUNGARY.

Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 6G.
W91-02724

MICROBIAL COLONIZATION OF AQUIFER SEDIMENT EXPOSED IN A GROUNDWATER WELL IN NORTHERN GERMANY.

Kiel Univ. (Germany, F.R.). Inst. fuer Allgemeine Mikrobiologie. P. Hirsch, and E. Rades-Rohkohl. Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 10, p 2963-2966, October 1990. 1 fig, 3 tab, 16 ref.

Descriptors: \*Aquifers, \*Germany, \*Groundwater quality, \*Microorganisms, \*Sediment analysis, Carbon cycle, Interstitial water, Microbiological studies, Population dynamics, Wells.

Microbial growth within the water-saturated sub-Microbial growth within the water-saturated sub-surface environment was investigated by exposing sandy sediments to groundwater for 12 weeks, at a depth of 10 or 20 m in a stainless-steel groundwater well. Washing and heating the sediment to 600 C (removal of organic carbon) prior to the exposure did not prevent the natural microbial community from colonizing the sterilized sediment samples. Total cell counts of more than 10 or 100 million/g of dried sediment were obtained. Viable cell counts of 100.000 cells/g on gliostrophic media indicated of dried sediment were obtained. Viable cell counts of 100,000 cells/g on oligotrophic media indicated the presence, within the exposed sediment, of a highly active and multiplying biota. Microscopic analysis of enrichments inoculated with exposed sediment samples revealed a total of 45 different morphotypes, approximately 42% of the microbial community observed in studies of this site. The interstitial water running off of the retrieved sediment contained only 17 morphotypes and had 600,000 viable cells/ml. (Author's abstract)

QUALITY CHARACTERIZATION OF GROUNDWATER IN KOILSAGAR PROJECT AREA, MAHABUBNAGAR DISTRICT, AREA, MAHABUBNAGAR DISTR ANDHRA PRADESH, INDIA. Osmania Univ., Hyderabad (India). For primary bibliographic entry see Field 2K. W91-02815.

HYDROGEOLOGICAL APPROACH TO IN-VESTIGATION IN KARST FOR POSSIBLE MODIFICATION OF GROUNDWATER REGIME AND INCREASE OF RECOVERABLE

GEOZAVOD, Belgrade (Yugoslavia). For primary bibliographic entry see Field 4B. W91-02820

EXPERIMENTAL INVESTIGATION OF VARIABLE DENSITY FLOW AND MIXING IN HOMOGENEOUS AND HETEROGENEOUS

Ohio State Univ., Columbus, Dept. of Geology

Ohio State Curry, and Mineralogy. R. A. Schincariol, and F. W. Schwartz. Water Resources Research WRERAQ, Vol. 26, No. 10, p 2317-2329, October 1990. 14 fig. 5 tab, 29

Descriptors: \*Density stratification, \*Groundwater movement, \*Heterogeneity, \*Homogeneity, \*Mixing, \*Saline water intrusion, \*Varied flow, Groundwater, Hydraulic conductivity, Porous

Variable density groundwater flow in homogeneous, layered and lenticular porous media was studied. At the scale of the experiments the flow of dissolved mass in water depends upon both forced and free convection. In addition, density differand free convection. In addition, density differences as low as 0.0008 g/cc (1000 mg/L sodium chloride) between a plume of dense water and ambient groundwater in a homogenous medium produces gravitational instabilities at realistic groundwater velocities. These instabilities are manifested by lobe-shaped protuberances that formed first along the bottom edge of the plume and later within the plume. As the density difference increases to 0.0015 g/cc (2000 mg/L sodium chloride), or higher, this unstable mixing due to convective dispersion significantly alters the spreading process. In a layered medium, reductions in hydraulic conductivity of the order of half an order of magnitude or less can influence the flow of the dense plume. Dense water may accumulate along or magnitude or less can influence the flow of the dense plume. Dense water may accumulate along bedding interfaces, which when dipping can result in plume migration velocities larger than ambient groundwater velocities. In a lenticular medium the combination of convective dispersion and nonuniform flow due to heterogeneities result in relatively large dispersion. Scale considerations, further, indicate that convective dispersion may received an indicate that convective dispersion may provide an important component of mixing at the field scale. (Author's abstract) W91-02862

APPARENT DISPERSION IN TRANSIENT

APPARENT DISPERSION IN TRANSIENT GROUNDWATER FLOW.
Geological Survey, Reston, VA.
D. J. Goode, and L. F. Konikow.
Water Resources Research WRERAQ, Vol. 26,
No. 10, p 2339-2351, October 1990. 14 fig, 19 ref,
append

Descriptors: \*Dispersion, \*Groundwater, \*Groundwater movement, \*Unsteady flow, Aquifer characteristics, Aquifers, Dispersivity, Flow characteristics, Scaling, Solute transport, Storativity, Temporal distribution.

Effects of large-scale temporal velocity fluctua-tions, particularly changes in the direction of flow, on solute spreading in a two-dimensional aquifer are generally believed to result from spatial varia-bility in aquifer properties. Relations for apparent longitudinal and transverse dispersivity are developed through an analytical solution for dispersion in a fluctuating, quasi-steady uniform flow field, in which storativity is zero. For transient flow, spatial moments are evaluated from numerical solutions. moments are evaluated from numerical solutions. Ignored or unknown transients in the direction of flow primarily act to increase the apparent transverse dispersivity because the longitudinal dispersivity is acting in a direction that is not the assumed flow direction. This increase is a function of the angle between the transient flow vector and the assumed steady state flow direction and the ratio of transverse to longitudinal dispersivity. The maximum effect on transverse dispersivity occurs if storativity is assumed to be zero, such that the flow field responds instantly to boundary conditions. Theoretical and field analyses indicate that longitudinal dispersivity is scale-dependent in porous media and that transverse dispersivity is generally one or more orders of magnitude smaller, causing solute plumes to be long and thin. (Author's abstract) W91-02864

SOME ANOMALOUS FEATURES OF FLOW AND SOLUTE TRANSPORT ARISING FROM FRACTURE APERTURE VARIABILITY.

FRACTURE APERTURE VARIABILITY.
Royal Inst. of Tech., Stockholm (Sweden). Dept.
of Chemical Engineering.
L. Moreno, C. Tsang, Y. Tsang, and I. Neretnieks.
Water Resources Research WRERAQ, Vol. 26,
No. 10, p 2377-2391, October 1990. 11 fig. 4 tab, 26
ref. US Department of Energy contract No. DEAC03-76F00098.

Descriptors: \*Fracture permeability, \*Geologic fractures, \*Groundwater movement, \*Model studies, \*Solute transport, \*Statistical models, Dispersion, Flow equations, Hydrologic models, Injection, Tracers.

Model fractures with variable apertures were generated by a statistical method, and water flow and tracer transport in these fractures are calculated. tracer transport in these fractures are calculated. Tracer injection and collection are simulated for parallel and convergent flow fields. The impact of the use of different injection flow rates and the different locations of injection and collection points indicates that the transport time, dispersion, and the so-called mass balance fracture aperture are very sensitive to the location of the injection point and the injection flow rate. These anomalous effects appear to be consistent with observations in several recent field experiments. The implications of the calculated results on the analysis of tracer tests concludes that because of the stochastic nature of variable fracture apertures (and their permeabilities) a point tracer test in a fracture is not sufficient to characterize the properties of the fracture. Dispersivities and apertures calculated not sufficient to characterize the properties of the fracture. Dispersivities and apertures calculated from different tracer tests in the same fracture may vary by orders of magnitude depending on the flow rate and the location of the injection. However, a line injection of tracer, averaged over a series of adjacent points, may avoid some of these problems. (Author's abstract) W91-02867

ESTIMATING GROUNDWATER EXCHANGE WITH LAKES: 1. THE STABLE ISOTOPE MASS BALANCE METHOD.

Geological Survey, Madison, WI. Water Resources Div.

sources Liv. D. P. Krabbenhoft, C. J. Bowser, M. P. Anderson, and J. W. Valley. Water Resources Research WRERAQ, Vol. 26, No. 10, p 2445-2453, October 1990. 8 fig, 2 tab, 42 ref. National Science Foundation Contract No. BSR 8514430.

Descriptors: "Groundwater, "Hydrologic budget, \*Isotope studies, "Lakes, "Mass balance, "Surface-groundwater relations, "Wisconsin, Aquifers, Ef-fluent water, Influent water, Mathematical models, Piezometers, Seepage, Spatial distribution, Tempo-

Groundwater inflow and outflow contributions to the hydrologic budget of lakes can be determined using a stable isotope (oxygen-18/oxygen-16) mass balance method. The stable isotope method pro-vides a way of integrating the spatial and temporal complexities of the flow field around a lake, thereby offering an appealing alternative to the tradi-tional time and labor intensive methods using a seepage meter and an extensive piezometer net-work. This method is applied to a lake in northern work. This method is applied to a lake in northern Wisconsin, demonstrating that it can be successfully applied to lakes in the upper Midwest where thousands of similar lakes exist. Inflow and outflow rates calculated for the Wisconsin lake using the isotope mass balance method are 29 and 54 cm/yr, respectively, which compare well to estimates, derived independently using a three-dimensional groundwater flow and solute transport model, of 20 and 50 cm/yr. Such a favorable comparison lends confidence to the use of the stable isotope method to estimate groundwater exchange with lakes. In addition, utilization of stable isotopes in

### Water In Soils-Group 2G

studies of groundwater-lake systems lends insight into mixing processes occurring in the unsaturated zone and in the aquifer surrounding the lake and verifies assumed flow paths based on head measurements in piezometers. (See also W91-02874) (Author's abstract) W91-02873

ESTIMATING GROUNDWATER EXCHANGE WITH LAKES: 2. CALIBRATION OF A THREE-DIMENSIONAL, SOLUTE TRANSPORT MODEL TO A STABLE ISOTOPE PLUME. Geological Survey, Madison, WI. Water Reources Div

D. P. Krabbenhoft, M. P. Anderson, and C. J.

Water Resources Research WRERAQ, Vol. 26, No. 10, p 2455-2462, October 1990. 7 fig, 4 tab, 44 ref. National Science Foundation Contract No.

Descriptors: \*Calibrations, \*Groundwater, \*Hydrologic models, \*Isotope studies, \*Lakes, \*Plumes, \*Solute transport, \*Surface-groundwater relations, \*Wisconsin, Effluent water, Flow rates, Influent water, Mathematical models, Seasonal distribution, Temporal distribution, Water table.

A three-dimensional groundwater flow and solute transport model was calibrated to a plume of water described by measurements of delta-oxygen-18 and used to calculate groundwater inflow and outflow rates at a lake in northern Wisconsin. The flow model was calibrated to observed hydraulic gradients and estimated recharge rates. Calibration of the solute transport submodel to the configuration of a stable isotope (oxygen-18) plume in the contig-uous aquifer on the downgradient side of the lake provides additional data to constrain the model. A good match between observed and simulated temporal variations in plume configuration indicates that the model closely simulated the dynamics of the real system. The model provides information on natural variation of rates of groundwater inflow, lake water outflow, and recharge to the water table. Inflow and outflow estimates compare favorably with estimates derived by the isotope mass balance method. Model simulations agree mass balance method. Model simulations agree with field observations that show groundwater inflow rates are more sensitive to seasonal variations in recharge than outflow. (See also W91-02873 (Author's abstract) W91-02874

COUPLED INVERSE PROBLEMS IN GROUNDWATER MODELING: 1, SENSITIVI-TY ANALYSIS AND PARAMETER IDENTIFICATION.

California Univ., Los Angeles. Dept. of Civil Engi-

neering.
For primary bibliographic entry see Field 7C.
W91-02879

COUPLED INVERSE PROBLEMS IN GROUNDWATER MODELING: 2. IDENTIFIABILITY AND EXPERIMENTAL DESIGN. California Univ., Los Angeles. Dept. of Civil Engineering. For primary bibliographic entry see Field 7C. W91-02880

NUMERICAL SIMULATION OF SOLUTE TRANSPORT IN THREE-DIMENSIONAL, RANDOMLY HETEROGENEOUS POROUS

Lawrence Livermore National Lab., CA. Earth Sciences Dept.
For primary bibliographic entry see Field 5B.
W91-02881

ANALYTICAL TRAVELING WAVE SOLU-TIONS FOR TRANSPORT WITH NONLINEAR AND NONEQUILIBRIUM ADSORPTION. Agricultural Univ., Wageningen (Netherlands).
Dept. of Soil Science and Plant Nutrition. For primary bibliographic entry see Field 2G. W91-02882

APPLICATION OF THE ARNOLDI ALGORITHM TO THE SOLUTION OF THE ADVECTION-DISPERSION EQUATION. Manitoba Univ., Winnipeg. Dept. of Geological For primary bibliographic entry see Field 5B. W91-02883

STOCHASTIC ANALYSIS OF THE CONCENTRATION VARIABILITY IN A THREE-DI-MENSIONAL HETEROGENEOUS AQUIFER, Nationale Genossenschaft fuer die Lagerung Ra-dioaktiver Abfaelle, Baden (Switzerland). E. G. Vomvoris, and L. W. Gelhar.

E. G. Vomvoris, and L. W. Gelhar. Water Resources Research WRERAQ, Vol. 26, No. 10, p 2591-2602, October 1990. 9 fig. 3 tab, 34 ref, append. U. S. EPA Cooperative Agreement CR-813359-01-1, National Science Foundation Grant CES-8814615.

Descriptors: \*Aquifers, \*Groundwater movement, \*Heterogeneity, \*Mathematical models, \*Model studies, \*Path of pollutants, \*Solute transport, \*Stochastic models, Anisotropy, Correlation analysis, Dispersivity, Hydraulic conductivity, Wave be-

A spectrally based perturbation approach is used to evaluate the concentration variability for a steady concentration field in a three-dimensional statistically homogeneous and anisotropic aquifer. The analysis assumes small, locally stationary concentration perturbations, and consequently, is valid only after mean displacements that are large compared to the scale of aquifer heterogeneity. The concentration variance is proportional to the square of the local mean concentration gradient and the variance and the correlation scales of log-hydraulic conductivity (In K) and is inversely proand the variance and the correlation scales of log-hydraulic conductivity (ln K) and is inversely pro-portional to the local dispersivity. The concentra-tion covariance function is highly anisotropic, with the largest correlation length aligned to the mean flow direction. Another important finding is the sensitivity of the longitudinal persistence of the concentration field to the high wave number be-havior of the input ln K spectrum. The commonly employed exponential-type covariance function, which corresponds to a nondifferentiable random field, results in extremely large concentration cor-relation lengths along the flow direction. Input spectra corresponding to differentiable fields with more rapid high wave number cutoffs produce a significant reduction of the longitudinal correlation length. (Author's abstract) length. (Author's abstract) W91-02884

ORIGIN AND EVOLUTION OF FORMATION WATERS, ALBERTA BASIN, WESTERN CANADA SEDIMENTARY BASIN: I. CHEMIS-

Alberta Univ., Edmonton. Dept. of Geology. For primary bibliographic entry see Field 2K. W91-02888

ORIGIN AND EVOLUTION OF FORMATION WATERS, ALBERTA BASIN, WESTERN CANADA SEDIMENTARY BASIN. II. ISO-TOPE SYSTEMATICS AND WATER MIXING. Alberta Univ., Edmonton. Dept. of Geology. For primary bibliographic entry see Field 2K. W91-02889

SULPHUR AND OXYGEN ISOTOPES OF DIS-SOLVED SULPHUR SPECIES IN FORMA-TION WATERS FROM THE DOGGER GEO-THERMAL AQUIFER, PARIS BASIN,

Bureau de Recherches Geologiques et Minieres, Orleans (France). Orieans (France).
For primary bibliographic entry see Field 2K.
W91-02890

MODELLING OF THE EVOLUTION OF GROUND WATERS IN A GRANITE SYSTEM AT LOW TEMPERATURE: THE STRIPA GROUND WATERS, SWEDEN. Paris-7 Univ. (France). Lab. de Geochimie des

For primary bibliographic entry see Field 2K. W91-02893

ANALYSIS OF HYDROLOGIC IMPACT OF QUARRYING SYSTEM BY 3-D FINITE ELE-MENT MODEL. Padua Univ. (Italy). Dipt. di Metodi e Modelli Matematici per le Scienze Applicate. For primary bibliographic entry see Field 4C. W91-02921

CONTAMINANT MIGRATION THROUGH FRACTURED TILL INTO AN UNDERLYING AQUIFER.
University of Western Ontario, London. Geotech-

onical Research Centre.
For primary bibliographic entry see Field 5B.
W91-02941

MIGRATION OF POLLUTANTS IN GROUND-WATER: IV. MODELING OF THE PUMPING OF CONTAMINANTS FROM FRACTURED BEDBOCK

Vanderbilt Univ., Nashville, TN. Dept. of Chemis-

Try.

D. J. Wilson, and R. D. Mutch.

Environmental Monitoring and Assessment

EMASDH, Vol. 15, No. 2, p 183-199, September 1990, 13 fig. 3 tab, 27 ref.

Descriptors: \*Bedrock, \*Geologic fractures, \*Groundwater movement, \*Groundwater pollution, \*Mathematical models, \*Model studies, \*Path of pollutants, Cleanup operations, models, Diffusion, Flushing.

The removal of soluble contaminants from frac-The removal of soluble contaminants from frac-tured porous bedrock by means of a recovery well was modeled by means of a lumped parameter approach. This simple mathematical model, well-adapted for use with readily available microcom-puters, yielded results which depended on the vari-ous parameters of the model in intuitively expected ous parameters of the model in intuitively expected ways. A laboratory column model in this study was helpful, within limits, in evaluating some parameters needed in the field flushing models. The use of local equilibrium models for the flushing of fractured bedrock can be expected to yield removal times which are only a small fraction of the time which will actually be required, due to the slow release of contaminant by diffusion from the immobile pore liquid. The situation could be generally worse than what was obtained in this study in which medium block radii of the order of a few centimeters were used, while spacing of the fracentimeters were used, while spacing of the fracwhich menium block radii or the order of a few centimeters were used, while spacing of the frac-tures could easily be a meter or more. An increase in the block size by a factor of 10 resulted in a decreased in the time constant for diffusion trans-port by a factor of .01. Diffusion transport may very well be a severely limiting factor in the rate of cleanup of sites by pump-and-treat operations. (See also W85-06290) (Medina-PTT) W91-02945

MODEL TO PREDICT AND ASSESS THE EF-FECTS OF GROUNDWATER WITHDRAWAL ON THE VEGETATION IN THE PLEISTO-CENE AREAS OF THE NETHERLANDS. Rijksinstituut voor Natuurbeheer, Leersum (Neth-

For primary bibliographic entry see Field 6G. W91-02949

### 2G. Water In Soils

PORE SIZE, PARTICLE SIZE, AGGREGATE SIZE, AND WATER RETENTION. Minnesota Univ., St. Paul. Dept. of Soil Science. L. Wu, J. A. Vomocii, and S. W. Childs. Soil Science Society of America Journal SSSJD4, Vol. 54, No. 4, p 952-956, July/August 1990. 3 fig, 3 tab, 22 ref.

Descriptors: \*Particle size, \*Pore size, \*Soil aggregates, \*Soil moisture retention, \*Soil water, Mathematical analysis, Soil properties, Soil texture, Soil types, Statistical analysis.

### Field 2-WATER CYCLE

### Group 2G-Water In Soils

Measurements of water retention and pore-size distribution for a soil are time consuming and affected by changes in aggregate-size distribution. A method of compared distribution curves was used to relate distributions of pore size (PO), particle size (PA), aggregate size (AG), and pore size from water retention (WR). Seven surface soils varying in texture and aggregation were tested. After normalization to 100% volume, the pore-, particle, and aggregate-size distribution, as well as water-retention (converted to pore diameter) curves were retention (converted to pore diameter) curves were and aggregate-size distribution, as well as water-retention (converted to pore diameter) curves were each fitted to a linearly transformed logistic func-tion to evaluate their interrelations using R(m/n), a coefficient for the ratio of the diameters of compotion to evaluate their interrelations using R(m/n), a coefficient for the ratio of the diameters of component m to component n. Identical distribution curves have an R(m/n) value of 1. The R(PO/PA) and R(WR/PA) for the seven soils ranged from 0.25 to 2.26 and from 0.18 to 1.34, respectively, indicating that the theoretical packing parameters of 0.225 to 0.414 do not hold for PA distribution. The R(PO/AG) ranged from 0.06 to 0.23 and R(WR/AG) from 0.04 to 0.16. Both ranges of R values smaller than the theoretical packing parameters suggests interactions may occur between large and small aggregates. However, R(PO/AG) and R(WR/AG) values were more consistent and were significantly related to aggregation level and bulk density, suggesting that AG distribution should be used as a parameter to predict PO distribution and water retention curves and PO distribution from Hg intrusion gave R(PO/WR) ranging from 0.78 to 2.59, showing that equivalent PO for a given soil is not the same when different measuring methods are used. (Author's abstract)

COUPLED WATER AND HEAT TRANSPORT

IN RIDGED SOILS.

Iowa State Univ., Ames. Dept. of Agronomy.

J. G. Benjamin, M. R. Ghaffarzadeh, and R. !

Soil Science Society of America Journal SSSJD4, Vol. 54, No. 4, p 963-969, July/August 1990. 7 fig, 3 tab, 26 ref.

Descriptors: \*Heat transfer, \*Mathematical models, \*Model studies, \*Ridging, \*Soil temperature, \*Soil water, \*Tillage, Field tests, Model testing, Ridged soils

Study of ridge-tillage effects on the soil environment has been impeded by the lack of models to describe adequately water and heat movement in the ridge system. The ridge system introduces many nonuniform characteristics into the field problem, such as variable solar radiation across the problem, such as variable solar radiation across the soil surface, unevenly distributed surface mulches, and variable water and heat transport properties caused by ridge construction or wheel traffic. A finite-element model was developed to simulate coupled water and heat flow in ridge systems. The finite-element solution scheme was chosen because of the ease by which nonuniform soil transport properties and nonuniform boundary conditions can be included in the problem specifications. Model predictions of soil water and temperature were compared with field measurements for two ridge configurations. Predicted and measured average daily temperatures over a 10-d period were age daily temperatures over a 10-d period were within 1 C and water contents were within 0.02 cu m/cu m for 80% of the measurements. (Author's

ORGANIC SELENIUM DISTRIBUTION IN SE-

ORGANIC SELENIONI DISTRIBUTION
LECTED CALIFORNIA SOILS.
Oregon Graduate Inst. of Science and Technology, Beaverton. Dept. of Environmental Science a For primary bibliographic entry see Field 5B. W91-02134 Engineering.

WATER-DROP KINETIC ENERGY EFFECT ON INFILTRATION IN SODIUM-CALCIUM-

MAGNESIUM SOILS.
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.

Soil Science Society of America Journal SSSJD4.

Vol. 54, No. 4, p 983-987, July/August 1990. 4 fig, 30 ref. U.S.-Israel Binational Agric. Res. and Development Fund Grant I-743-84.

Descriptors: \*Fluid drops, \*Infiltration rate, \*Ions, \*Rainfall impact, \*Rainfall infiltration, \*Soil water, Calcium, Kinetic energy, Magnesium, Simulated rainfall, Sodium, Soil aggregates, Soil chemistry, Soil types, Surface sealing.

The effect of complementary adsorbed ion (Ca vs. Mg) in the presence of Na on seal formation and water infiltration in two soils (Calcic Haploxeralf and Typic Rhodoxeralf) at several kinetic energies of water drops was studied using rain simulators. The infiltration rate (IR) of the soils was lower for the Na-Mg soils than for the Na-Ca soils at the studied kinetic energy range of the water drops (3.2-22.9 kJ/cu m). The higher the kinetic energy, the steeper the drop in IR. The steady-state IR and the cumulative water depth required to reach steady-state IR were both decreased with increassteady-state IR were both decreased with increas-ing kinetic energy of the water drops. Adsorbed Mg on montmorillonitic soils had a specific effect on IR whether or not the soil contained calcium carbonate. Aggregates with adsorbed Na and Ca ions were more stable than those with adsorbed Na and Mg ions when they were exposed to water drops having a kinetic energy in the range of 8.0 to 12.5 kJ/cu m. The specific effect of Mg on IR was explained by the presence of Mg ions on the exter-nal surfaces of the clay tactoids and the larger hydration shell of the Mg ion compared to Ca. (Author's abstract) W91-02135

WATER DROPLET ENERGY AND SOIL AMENDMENTS: EFFECT ON INFILTRATION AND EROSION.

Soil and Irrigation Research Inst., Pretoria (South

H. J. C. Smith, G. J. Levy, and I. Shainberg Soil Science Society of America Journal SSSJD4, Vol. 54, No. 4, p 1084-1087, July/August 1990. 4 fig, 2 tab, 20 ref.

Descriptors: \*Erosion control, \*Fluid drops, \*Infiltration rate, \*Rainfall impact, \*Rainfall infiltration, \*Soil amendments, \*Soil erosion, \*Soil water, Electrolytes, Kinetic energy, Simulated rainfall, Surface sealing, Water quality.

The impact energy of water droplets from rain or overhead sprinklers can cause a seal to form at the soil surface. This constitutes a severe problem in agricultural lands in the arid and semiarid regions. Spreading a soil conditioner on the surface of the soil and providing a constant source of electrolytes may prevent seal formation. The effect of droplet may prevent seal formation. The effect of droplet impact energy and water quality on infiltration and erosion was studied, using a tank drip-type rain simulator, in a sandy loam soil (Typic Rhodoxeralf) treated with an anionic polyacrylamide (PAM) and phosphogypsum. Three kinetic energies of 3-mm diameter drops were obtained by varying their falling heights. The two qualities of water were distilled water and tap water, to simulate rain and ririgation water, respectively. Increasing the impact energy reduced the infiltration rate (IR), cumulative infiltration (rain intake), and soil erosion in all treatments. Addition of PAM in the presence of electrolytes (either phosphogypsum or tap water) increased both final IR and cumulative infiltration by 7-fold to 8-fold compared to the control, and was much more effective than PAM, phosphogypsum or tap water alone. The PAM phosphogypsum or tap water alone. The PAM plus electrolyte treatments decreased soil erosion by more than one order of magnitude compared with the control. (Author's abstract) W91-02136

POLYMER EFFECTS ON EROSION UNDER LABORATORY RAINFALL SIMULATOR CON-DITIONS.

Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center. For primary bibliographic entry see Field 2J.

W91-02137

MACROPOROSITY AND ITS RELATION TO SATURATED HYDRAULIC CONDUCTIVITY UNDER DIFFERENT TILLAGE PRACTICES.

Minnesota Univ., St. Paul. Dept. of Soil Science. S. D. Logsdon, R. R. Allmaras, L. Wu, J. B. Swan, and G. W. Randall.

Soil Science Society of America Journal SSSJD4, Vol. 54, No. 4, p 1096-1101, July/August 1990. 4 fig, 4 tab, 22 ref.

Descriptors: \*Hydraulic conductivity, \*Porosity, \*Soil water, \*Tillage, Analytical methods, Infiltration, Macropores, Minnesota, Pore size, Soil texture, Soil types, Wisconsin.

Tillage management influences the distribution of macropores (biopores, cracks, interpedal planes, and packing voids) that may provide pathways for rapid inflitration of water. To aid in predicting ranges of saturated hydraulic conductivity (Ksat), ranges of saturated hydraunic conductivity (Asai), macropore distribution in situ was characterized by exposing selected horizontal planes and tracing macropores on clear polyethylene sheets. A meth-ylene blue solution was used to indicate macropore ylene blue solution was used to indicate macropore continuity through the pressure pan. Sixteen undisturbed cores were taken in a grid pattern from each Ap horizon and adjacent subsoil for determination of Ksat. Field marking on plastic sheets was superior to photographic slides as a technique to characterize macropores because film noise (false pores) was eliminated, overall analysis time was reduced, and different features could be separated for analysis. However, a bias of pore size between observers was possible. Four sites in southern Minnesota and Wisconsin with four different soil series nesota and Wisconsin with four different soil series were examined. Below the maximum tillage depth, macropores were present at all locations, but tillage disrupted continuity of pores from the surface. No-till had macropores throughout the upper 70 cm with continuity observed in the 0-35 cm range. Numbers of pores > 0.4 mm diam/sq m ranged from 100 to > 3,000, representing 0.1 to 2% of the total area. When present, horizontal crack length ranged from 1.7 to 19.3 m/sq m. Measured Ksat on undisturbed detached cores ranged from 1.1 to 180 microm/s with CVs ranging from 44 to 197%. The Ksat could be estimated within a range (out of eight classes) from descriptions of biopore area, cracks, soil structure, and soil texture. (Author's cracks, soil structure, and soil texture. (Author's abstract) W91-02138

SOIL WATER DIFFUSIVITY DETERMINA-TION BY A MODIFIED ONE-STEP OUTFLOW METHOD.

Nebraska Univ.-Lincoln. Dept. of Agronomy. S. Mu'azu, J. Skopp, and D. Swartzendruber. Soil Science Society of America Journal SSSID4, Vol. 54, No. 4, p 1184-1186, July/August 1990. 2

Descriptors: \*Analytical methods, \*Diffusivity, \*Hydraulic conductivity, \*Mathematical analysis, \*Soil water, Aeration zone, Estimating equations, Mathematical equations, One-step outflow proce-

One-step outflow procedures represent potentially rapid and convenient procedures to obtain soil water diffusivity and unsaturated hydraulic conductivity data. Modifications of the existing procedures that improve and simplify the estimation of dures that improve and simplify the estimation of the soil water diffusivity and associated water conthe soil water dimissivity and associated water Con-tent were derived. An equation was derived that describes the soil water diffusivity as a function of average soil water content rather than the water content at the top end of the soil core. The results content at the top end of the soil core. The results may be used over a range of water contents. The modifications presented provide a simpler analysis that is more readily applied to one-step outflow experiments. (Author's abstract)
W91-02140

FOUNDATION PROBLEMS IN CHAMPLAIN CLAYS DURING DROUGHTS. I: RAINFALL DEFICITS IN MONTREAL (1930-1988).

Ecole Polytechnique, Montreal (Quebec). Dept. of Civil Engineering. For primary bibliographic entry see Field 8D. W91-02147

### Water In Soils-Group 2G

ANALYSIS OF THE IN SITU CONSTANT-HEAD PERMEABILITY TEST IN CLAYS, McGill Univ., Montreal (Quebec). For primary bibliographic entry see Field 7B. W91-02148

FIELD FROST HEAVE MEASUREMENT AND PREDICTION DURING PERIODS OF SEA-SONAL FROST.

Agriculture Canada, Ottawa (Ontario). Land source Research Centre. For primary bibliographic entry see Field 2C. W91-02150 ada, Ottawa (Ontario). Land Re-

HYDROGEOCHEMICAL PROCESSES CONTROLLING THE TRANSPORT OF DISSOLVED ORGANIC CARBON THROUGH A FORESTED HILLSLOPE.

Oak Ridge National Lab., TN. Environmental Sci-

For primary bibliographic entry see Field 5B. W91-02159

SATURATED HYDRAULIC CONDUCTIVITY OF SCANDINAVIAN TILLS.
Chalmers Univ. of Technology, Goeteborg

For primary bibliographic entry see Field 2F. W91-02167

SATURATED HYDRAULIC CONDUCTIVITY OF CLAYEY TILLS AND THE ROLE OF

Technical Univ. of Denmark, Lyngby. Inst. for Teknisk Geologi.
For primary bibliographic entry see Field 2F.
W91-02168

UNSATURATED HYDRAULIC CONDUCTIVITY DETERMINED BY THE HOT AIR METHOD FOR SOME DANISH TILL SOILS. Department of Soil Tillage, Soil Physics and Irrigation, Tinglev (Denmark).

O. H. Jacobsen, and H. E. Jensen. Nordic Hydrology NOHYBB, Vol. 21, No. 2, p 133-140, 1990. 3 fig, 1 tab, 10 ref.

Descriptors: \*Analytical methods, \*Denmark, \*Hydraulic conductivity, \*Soil water, \*Till, \*Unsaturated flow, Aeration zone, Pore pressure, Pore size, Subsoil, Topsoil.

Many soil water transport processes such as infil-tration, soil water redistribution, uptake of water by plants, and evapotranspiration involve flow in unsaturated soil. Hydraulic conductivity as a func-tion of soil water content is one of the most impor-tant relations for successful simulation of unsaturaltant relations for successful simulation of unsaturated ed flow. Unsaturated hydraulic conductivity relations for topsoil and subsoil in 12 Danish till soils were obtained from measurements by the hot air method. The hot air method is simple, quick, and inexpensive to carry out, and it is applicable to a wider range of soil water contents than most other. inexpensive to carry out, and it is applicable to a wider range of soil water contents than most other experimental methods. In the range of pressure potentials within which the method is most suitable (pF values from 1.7 to 3.0) the hydraulic conductivities were found to be within the range of ten to the minus tenth power to ten to the minus seventh power m/s for topsoils, and ten to the minus eleventh power to ten to the minus eighth power m/s for subsoils. The hydraulic conductivity relations obtained may be related to the corresponding m/s for subsoils. The hydraulic conductivity rela-tions obtained may be related to the corresponding pF-curves. At any pF-value the subsoils differed more than the topsoils in hydraulic conductivity. (Author's abstract)

METHODS USED FOR CALCULATION OF PLANT AVAILABLE WATER IN NORDIC TILL SOILS. Copenhagen Univ. (Denmark). H. B. Madsen, H. Riley, and L. Lundin. Nordic Hydrology NOHYBB, Vol. 21, No. 2, p 141-152, 1990. 4 fig., 4 tab, 32 ref.

Descriptors: \*Analytical methods, \*Soil moisture retention, \*Soil water, \*Soil-water-plant relation-

ships, \*Till, Available water, Field capacity, Plant water potential, Soil horizons, Soil water potential.

Almost all of the Nordic countries were covered Almost all of the Nordic countries were covered by ice during the last ice age, and most of the land is covered by till, glaciofluvial sediments, and marine deposits. The storage capacity of a soil for water available for plant production is termed the root zone capacity (RZC). Three different methods of calculating the RZC for Nordic tills have been evaluated using existing published data. Calculation of the RZC utilizes the soil water retendence for a particular till using the feeltion curve for a particular till, using the field capacity and the permanent wilting point to calcu-late the available water content (AWC). The late the available water content (AWC). The AWC is then combined with the root density of different soil horizons to calculate the RZC, using one of several methods. The first method calculates the AWC within an effective root depth, and is a crude indicator of the plant-available water content in the root zone. The technique is useful for transforming soil maps into RZC maps, because the data requirements are low and mean values are the data requirements are low and mean values are used, but it is not very accurate for calculating the RZC on single profiles. The second method of calculating RZC calculates the sum of water actually used by plants from different soil layers; this method requires data from the entire soil water retention curve, and very few investigations of this type have been carried out in the Nordic countries. The third method of calculating RZC uses the simulation model HEIMDAL. The model assumes that the state of water in the soil-plant atmosphere. that the state of water in the soil-plant-atmosphere system can be quantitatively characterized at any moment, and that changes in the system can be described by equations. Laboratory-derived parameters for soils and plants are combined with climatic factors to calculate a variety of outputs, including summed up transpiration and the soil water status at wilting. This method requires very large amounts of data and provides very detailed information for single profiles. (Tappert-PTT) W91-02170

SLOWLY REVERSIBLE SORPTION OF ALI-PHATIC HALOCARBONS IN SOILS, I. FOR-MATION OF RESIDUAL FRACTIONS, Connecticut Agricultural Experiment Station, New Haven. Dept. of Soil and Water. For primary bibliographic entry see Field 5B. W91-02209

SLOWLY REVERSIBLE SORPTION OF ALI-PHATIC HALOCARBONS IN SOILS. II. MECHANISTIC ASPECTS. Connecticut Agricultural Experiment Station, New Haven. Dept. of Soil and Water. For primary bibliographic entry see Field 5B. W91-02210

ALTITUDE OF POTENTIOMETRIC SURFACE FALL 1985, AND HISTORIC WATER-LEVEL CHANGES IN THE FORT PILLOW AQUIFER IN WESTERN TENNESSEE.

Geological Survey, Nashville, TN. Water Resources Div. For primary bibliographic entry see Field 2F. W91-02248

IRRIGATION TRIALS: BASIS FOR THE DESIGN OF FURROW SYSTEMS. Irrigation (Ghana). Development Authority, For primary bibliographic entry see Field 3F. W91-02315

HYDROLOGIC REGIME UNDER NATURAL CLIMATIC CONDITIONS IN THE LATERITIC SOIL OF BURKINA FASO (REGIME HYDRI-QUE EN CONDITIONS CLIMATIQUES NATURELLES D'UN SOL LATERITIQUE DU BURKINA FASO).

Ecole Inter-Etats d'Ingenieurs de l'Equipement Rural, Ouagadougou (Burkina Faso). E. Walbadet, P. Perrochet, and A. Mermoud.

IN: The State-of-the-Art of Hydrology and Hy-drogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouaga-

dougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 361-369, 3 fig. English summary.

Descriptors: \*Arid lands, \*Burking Faso, \*Evapo Descriptors: "Arti lands, "Burkina Faso, "Evaporation, "Hydrological regime, "Soil moisture, "Soil moisture meters, "Soil water, Cultivated lands, Infiltration, Neutron moisture profiles, Soil profiles, Vegetation effects, Wetting.

During the first three months of the rainy season of 1987, the evolution of neutron moisture profiles was observed under traditional crops and under bare soil. The temporal variations of water storage were calculated from these measurements at two sites (at Gampela, Burkina Faso). Interesting com-parisons could be made concerning infiltration. retention, and drying of the soil profiles. During the period of observation the wetting front reached a depth of 150 cm under the cultivated plot but did not penetrate farther than 50 cm under bare soil. Moreover, in less than 3 wk after the last rain the quantities of water stored in the two profiles were reduced to their initial values observed at the end of the dry season. (See also W91-02288) (Author's abstract) W91-02317

WATER TRANSFER IN POROUS NON-SATURATED ROCK AND AQUIFER RECHARGE IN THE SUDANO-SAHELIAN CLIMATE (TRANSFERT D'EAU EN MILIEU POREUX NON SATURE RECHARGE DES NAPPES EN CLIMAT SOUDANO-SAHELIEN).

Ecole Inter-Etats d'Ingenieurs de l'Equipement Rural, Ouagadougou (Burkina Faso). For primary bibliographic entry see Field 2F. W91-02319

HYDRAULIC PROPERTIES OF FOUR SOILS IN NIGER AND IMPLICATIONS FOR WATER BALANCE STUDIES.

International Crops Research Inst. for the Semi-Arid Tropics, Niamey (Niger).

M. V. K. Sivakumar, R. J. Lascano, and D. R.

Upchurch. Direction of the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 502-512, 8 fig, 10 ref.

Descriptors: \*Drainage, \*Hydraulic properties, \*Hydrologic budget, \*Infiltration, \*Model studies, \*Niger, \*Semiarid lands, \*Soil moisture retention, Hydrologic models, Mathematical models, Millet, Seasonal variation. Simulation.

In semi-arid regions of Africa, where rainfall variability is often large, plant-available water, which is estimated by water balance procedures, is a primary determinant of crop yields. Characterization of soil hydraulic properties is important for modeling drainage, a component of the water balance that is often ignored. Water balance studies of pearl millet were conducted in Niger from 1984-1987 on four soil types: a sand, a loamy sand, a sandy loam, and a loam. Soil samples were collected at 0.3 m depth increments from the surface to 2.1 m. Laboratory measurements of the soil mois-2.1 m. Laboratory measurements of the soil mois-ture retention (SMR) curve were made. Saturated hydraulic conductivities were measured and com-bined with SMR curves to calculate unsaturated bined with SMR curves to calculate unsaturated hydraulic conductivity functions. These hydraulic properties then were used in a simulation model to calculate drainage, which was different for the four soil types. With the aid of a drainage model, this study demonstrated that the drainage component in the water balance can be significant, even in years of adequate rainfall. Even for soils with a higher clay content drainage losses could be large. higher clay content, drainage losses could be large on a seasonal basis. Hence, water balance studies should either measure or calculate the drainage component. (See also W91-02288) (Rochester-

W91-02330

### Field 2-WATER CYCLE

### Group 2G-Water In Soils

WATER ASSESSMENT OF SOILS AND TRADI-TIONAL AGRICULTURAL CALENDARS IN UPPER BORGOU (REP. POP. DU BENIN) (BILANS D'EAU DES SOLS ET CALENDRIERS AGRICOLES TRADITIONNELS DANS LE HAUT BORGOU (R.P. BENIN)).

Universite Nationale du Benin, Cotonou. Dept. de Geographie. For primary bibliographic entry see Field 3F. W91-02367

RELATING SOIL COLOR TO SOIL WATER TABLE LEVELS.

Ohio State Univ., Columbus. Dept. of Agronomy. W. R. Guertal, and G. F. Hall. Ohio Journal of Science OJSCA9, Vol. 90, No. 4, p 118-124, September 1990. 6 fig, 1 tab, 21 ref.

Descriptors: "Soil color, "Soil properties, "Soil water table, "Water table, Drainage, Ohio, Seasonal variation, Soil profiles, Soil saturation, Soil water, Water table fluctuations, Water table pro-

Seasonal incidence of water tables in soils is one of the most important characteristics influencing their use and management. The relationship between depth to the water table and soil color was studied on a glacial till plain toposequence containing three soils (Blount, Glynwood and Morley) representative of those common throughout northwestern Ohio. As the soil drainage class changed from well drained to moderately well drained to somewhat poorly drained, the depth to low chroma colors decreased. The Morley soil had no low chroma fees than or equal to 2) colors except in the surface, where they were the result of organic matter accumulation. The Glynwood soil had low chroma colors beginning 37 cm below the soil surface, and the Blount soil had low chroma colors 28 cm below the soil surface. Low chroma mottles Seasonal incidence of water tables in soils is one of 28 cm below the soil surface. Low chroma mottles were the most abundant in the Blount soil profile. were the most abundant in the blount soil profile.

Decreasing depth to low chroma colors can be related to changes in the soil water table levels. The results suggested that gray colors (chroma of less than or equal to 2) in mottles indicate that the less than of equal to 2 in motites indicate that the horizon is near or just above the water table level. If the horizon is dominated by gray colors (gleyed) in the soil matrix, then that horizon is saturated much of the time. It can be concluded that the presence of colors of 2 chroma or less reliably predicts the depth to the water table. (MacKeen W91-02533

SOIL WATER RELATIONS ON A HILLTOP CORNFIELD IN CENTRAL APPALACHIA. Agricultural Research Service, Beckley, WV. Ap-palachian Soil and Water Conservation Research

D. G. Boyer, R. J. Wright, W. M. Winant, and H. D. Perry.
Soil Science SOSCAK, Vol. 149, No. 6, p 383-392,
June 1990. 6 fig, 5 tab, 15 ref.

Descriptors: \*Appalachian Mountains, \*Geohydrology, \*Soil water, \*Soil-water-plant relationships, Corn, Kriging, Loam, Mathematical analysis, Mathematical studies, Precipitation, Soil properties, Topography, West Virginia.

The topography of the Appalachian region strong-The topography of the Appalachian region strongly influences the environment for plant growth. A field study was conducted in 1984 and 1985 on a Gilpin silt loam in West Virginia to determine soil and environmental factors controlling corn (Zea mays L.) yield differences among landscape positions. Four plots were established at each of plocations including summit, shoulder (N. E. S. W. aspects). Although common management practices were used throughout the field, corn yields varied significantly among positions. Mean 'available water' as represented by the difference between gravimetric water determined over time and water retained at 1500 kPa, was the most important factor controlwater determined over time and water retained at 1500 kPa, was the most important factor control-ling corn production. The objectives of this study were to determine the relationship between soil physical properties, surface curvature, and precipi-tation catch on the distribution of soil water, with emphasis on the surface layer (0-15 cm depth).

Available water was always lower at the backslope sites than at the summer or shoulder sites. Higher clay content and lower infiltration capacity were associated with lower available water. Precipita-tion catch differences strictly followed the same pattern as available water between shoulder sites and summit. A cokriging analysis indicated that surface curvature may be useful for spatial representation of available water throughout the study site. (Author's abstract) W91-02592

SOME ASPECTS OF SOIL MOISTURE CONTROL FOR SOILS WITH SHALLOW GROUNDWATER LEVELS,

Agricultural Univ. of Warsaw (Poland). Dept. of Land Reclamation.

Land Reclamation.

T. Brandyk, and R. Romanowicz.

IN: Groundwater Management: Quantity and
Quality Proceedings of the Symposium held at
Benidorm, Spain, October 2-9, 1989. International
Association of Hydrological Sciences, Washington, DC. 1989. p 19-28, 5 fig, 9 ref.

Descriptors: \*Aeration zone, \*Model studies, \*Soil water, \*Soil-water-plant relationships, Control sys-tems, Decision making, Flow control, Hydraulic conductivity, Hydrologic models, Mathematical models, Root zone, Shallow aquifers, Soil moisture deficiency. Soil moisture retention.

Soil moisture control for soils with shallow groundwater levels is necessary to maintain the required moisture content in the root zone of the required moisture content in the root zone of the vegetation. Water management in the plant root zone requires a knowledge of the actual soil mois-ture content. Mathematical models based on the application of steady and unsteady soil moisture theory can be very helpful in this regard. Both steady and unsteady state soil moisture models of the unsaturated zone with an analytical exponential unsaturated hydraulic conductivity function were considered. The long-term soil moisture control problem was formulated using steady state soil moisture theory. In this case the typical control problem has an open-loop control structure. The short-term soil moisture control problem was for-mulated using unsteady state soil moisture theory. In this case it is possible to develop a closed-loop control structure. The long-term control concept was confirmed by field measurements of soil mois-ture pressure heads and numerical simulation of ture pressure heads and numerical simulation of unsteady state soil moisture flow. Due to the very complex form of the analytical solution of the unsteady state model its further linearization should be performed. This would allow development of closed-loop control algorithms for the short-term moisture control problem. (See also W91-02672) (Fish-PTT) W91-02674

NUMERICAL MODEL FOR SIMULATING THE IN-SITU VOLATILIZATION OF HYDRO-CARBON CONTAMINANTS IN SOILS. Colorado State Univ., Fort Collins. Dept. of Civil

Engineering.
For primary bibliographic entry see Field 5B.
W91-02705

PRECIPITATION, THROUGHFALL, SOIL SO-LUTION AND STREAMWATER CHEMISTRY IN A HOLM-OAK (QUERCUS ILEX) FOREST. Universidad Autonoma de Barcelona (Spain). Centre de Recerca Ecologica i Aplicacions Fores-

For primary bibliographic entry see Field 2K. W91-02744

SOIL WATER IN THE RIPARIAN ZONE AS SOURCE OF CARBON FOR A HEADWATER

University Coll. of North Wales, Bangor. School of Biological Sciences. For primary bibliographic entry see Field 2H. W91-02747

CALIBRATION OF TIME DOMAIN REFLEC-TOMETRY FOR WATER CONTENT MEAS-

UREMENT USING A COMPOSITE DIELEC-TRIC APPROACH.

Eidgenoessische Technische Hochschule, Zurich

Water Resources Research WRERAQ, Vol. 26, No. 10, p 2267-2273, October 1990. 4 fig. 2 tab, 21

Descriptors: \*Electrical properties, \*Instrumenta-tion, \*Measuring techniques, \*Soil moisture meters, \*Soil water, \*Soil water potential, \*Time domain reflectometry, Calibrations, Mathematical models, Neutron scattering, Regression analysis, Sensitivity analysis.

Time domain reflectometry (TDR) has been developed to an operational level for the measurement of soil water content during the past decade. TDR has become an alternative to the neutron scattering mas become an atternative to the neutron scattering method because it provides fast, precise and nonde-structive in situ measurements. One of the major disadvantages of the neutron scattering technique is that, due to the relatively high sensitivity of the is mai, due to the relatively migh scinativity of the signal to factors other than water content, site-specific calibration is usually required. A calibra-tion curve is developed for the TDR method which is not restricted to specific soil conditions. The calibration is based on a dielectric mixing model. Measurements of volumetric water content and dielectric number at eleven different field sites and dielectric number at eleven different field site representing a wide range of soil types were used to determine the parameter of the model by weighted nonlinear regression. The uncertainty (root mean square error) of water content values calculated with the optimized calibration curve was estimated not to exceed 0.013 cc/cc. This value is comparable to the precision of the thermogravimetric method. From a sensitivity analysis, the temperature dependence of the TDR signal may have to be corrected to obtain optimum accuracy. (Author's abstract) racy. (Author's abstract) W91-02857

COMPUTER-CONTROLLED 36-CHANNEL TIME DOMAIN REFLECTOMETRY SYSTEM FOR MONITORING SOIL WATER CON-

Amsterdam Univ. (Netherlands). Lab. for Physical Geography and Soil Science.

T. J. Heimovaara, and W. Bouten.
Water Resources Research WRERAQ, Vol. 26, No. 10, p 2311-2316, October 1990. 5 fig. 14 ref.

Descriptors: \*Automation, \*Measuring instru-ments, \*Reflectance techniques, \*Soil moisture meters, \*Soil water, \*Time domain reflectometry, Computer programs, Precision, Spatial distribu-tion, Temporal distribution.

Research on the spatial and temporal dynamics of soil water has long been impeded by the lack of an automated technique for the measurement of soil automated technique for the measurement or soil water content. A computer controlled time domain reflectometry (TDR) system makes a large number of measurements at different sites at predetermined time intervals possible. The system operates on 12 V dc and has the capability to monitor water content at 36 sites. The TDR clement of the system is the TEKTRONIX 1502B metallic TDR cable is the IEKIRONIX 1302B metallic IDK cable tester, connected to the transmission line probes through a 36-channel coaxial relay. The system is controlled by a Pascal program which obtains the TDR wave forms required for calculating water content. The algorithm used for the automatic analysis of the measurements is based on the calculations of the trend time of the TDR sizes. analysis of the measurements is based on the calcu-lation of the travel time of the TDR signal be-tween the beginning and the end of a three-wire probe. Quantification of the resolution of the 1502B cable tester is very difficult. Increasing the measurement frequency may be a means of filter-ing out noise and improving the precision of the method. (Brunone-PTT) W91-02861

SOLUTION OF A NONLINEAR ABSORPTION MODEL OF MIXED SATURATED-UNSATU-RATED FLOW.

La Trobe Univ., Bundoora (Australia). Dept. of

P. Broadbridge. Water Resources Research WRERAQ, Vol. 26, No. 10, p 2435-2443, October 1990. 4 fig, 22 ref,

Descriptors: \*Absorption, \*Groundwater move-ment, \*Hydrologic models, \*Saturated flow, \*Saturation zone, \*Soil water, \*Unsaturated flow, Gravity, Heterogeneity, Mathematical models,

In wetted soils, zones of saturation develop naturally in the vicinity of impermeable strata, surface ponds, and subterranean cavities. A nonlinear diffusion model of Fujita is adapted to solve a mixed saturated-unsaturated flow problem representing absorption of water by a soil with a constant pond depth at the surface. From the closed-form solution as among the surface of the depth at the surface. From the closed-form solution, an equation emerges which relates dimension-less sorptivity, dimensionless pond depth, and a single soil hydraulic nonlinearity parameter. For the whole range of soil types, the ratio of ponded sorptivity to unponded sorptivity increases significantly with pond depth but the ponding effect is stronger in weakly nonlinear soils than in highly nonlinear soils. In weakly nonlinear soils than in highly nonlinear soils the ponding effect is greatly enhanced by increasing the initial water content, but in extremely nonlinear soils the initial water content has little influence. The gravity-free ponded model, could be the foundation for other more sophisticated models which incorporate gravity or heterogeneity. (Author's abstract) W91-02872

UNCERTAINTY PROPAGATION WITH NU-MERICAL MODELS FOR FLOW AND TRANS-PORT IN THE UNSATURATED ZONE.

PORT IN THE UNSATURATED ZONE.
Polytechnic Univ., Brooklyn, NY. Dept. of Civil
and Environmental Engineering.
A. L. Protopapas, and R. L. Bras.
Water Resources Research WRERAQ, Vol. 26,
No. 10, p 2463-2474, October 1990. 6 fig, 1 tab, 23
ref. National Science Foundation Grant No.

Descriptors: \*Aeration zone, Mathematical models, \*Parameter estimation, \*Path of pollutants, \*Soil mechanics, \*Soil water, \*Soile transport, \*Uncertainty, \*Unsaturated zone, Agricultural practices, Flow equations, Groundwater, Numerical analysis, Soil properties.

The prediction of the distribution of water and solutes in the soil medium is essential for both efficient agricultural practice and for controlling the quality of subsurface water. Uncertainty propagation with numerical models for flow and transport in the unsaturated zone is studied using vector state-space methods. The output uncertainty is the state-space methods. The output uncertainty is the result of spatially, randomly varying parameters describing the soil hydraulic properties. An efficient state covariance propagation method is proposed, based on first-order linearization of the system dynamics. The approach has been previously used with groundwater flow models, and comparisons are made with a Monte Carlo simulation of infiltration in two soils with distinctly different soil properties. For coefficients of variation of the parameters, less than 0.3 the two methods agree parameters less than 0.3 the two methods agree well. The linearization method is found to be faster well. The linearzation inclined is found to be taster due to its analytical nature. The results are a first step for future research on parameter estimation, using the state-space linearization approach. (Au-thor's abstract) W91-02875

IMMOBILE WATER DURING SOLUTE TRANSPORT IN UNSATURATED SAND COL-

Commonwealth Scientific and Industrial Research

Commonweain Scientific and industrial Research Organization, Canberra (Australia). Div. of Soils. W. J. Bond, and P. J. Wierenga. Water Resources Research WRERAQ, Vol. 26, No. 10, p 2475-2481, October 1990. 2 fig. 2 tab, 24 ref, append. NRC project No. TD-2049 and EPA Grant No. R-811862-02-0.

Descriptors: \*Aeration zone, \*Sand, \*Soil col-umns, \*Soil water, \*Solute transport, \*Unsaturated flow, Flow pattern, Flow rates, Interstitial water, Steady flow, Unsteady flow.

The existence of preferential pathways for the flow of water through soils affects not only the distribu-tion of water in the soil but also the distribution of tion of water in the soil but also the distribution of solutes. Solute transport experiments examined the presence of immobile water in an unsaturated fine sand under different flow regimes. Both steady and unsteady flow conditions were imposed, but the average pore water velocity and water content were the same in each treatment. Evidence for the presence of an immobile water fraction was sought by fitting the concentration distributions using models both with and without an explicit term by fitting the concentration distributions using models both with and without an explicit term models both with and without an explicit term accounting for solute exchange with immobile water. Strong evidence was found for the presence of an immobile water fraction affecting the solute concentration distribution under steady flow conditions but not for unsteady flow. These apparently conflicting results are explained by the different water flow patterns arising from the two flow regimes, and suggest that care is needed when extrapolating the results of experiments carried out under one flow regime to a different flow regime. (Author's asstract)
W91-02876

MODELING INFILTRATION INTO A SEAL-ING SOIL.

ING SUIL.

Texas Agricultural Experiment Station, Lubbock.

R. I. Baumhardt, M. J. M. Romkens, F. D.

Whisler, and J. Y. Parlange.

Water Resources Research WRERAQ, Vol. 26,

No. 10, p 2497-2505, October 1990. 7 fig, 4 tab, 27

Descriptors: \*Hydraulic conductivity, \*Infiltra-tion, \*Mathematical models, \*Saturated flow, \*Soil porosity, \*Soil sealants, Rainfall intensity, Soil properties, Unsaturated flow.

Rain infiltration is often controlled by a less perme-able layer known as a seal. An important consider-ation in modeling infiltration into a sealing soil is the requirement of describing changes over time in both the saturated and unsaturated hydraulic conboth the saturated and unsaturated hydraulic conductivity of the surface. Infiltration through this layer was modeled numerically using a numerical model based on the Richard's equation with an algorithm which continuously updating the seal properties (saturated hydraulic conductivity, porosity, water entry value, specific water capacity) as a function of rainfall characteristics. The seal remains unchanged until the surface has reached incipient ponding. Subsequently, a rapid change in the hydraulic properties of the seal is imposed to reflect the effect of raindrop impact. Finally, an equilibrium state develops between seal formulation due to raindrop impact and seal erosion due to tion due to raindrop impact and seal erosion due to the rainstorm intensity effects. Model-predicted inthe rainstorm intensity effects. Model-predicted infiltration was similar to that observed during simulated rainstorms having various combinations of intensities and kinetic energy rates per millimeter of rain. A sensitivity analysis was performed to determine the effects of changes in seal and bulk soil properties, as well as simulation parameters, on infiltration. Seal formation was dependent on cumulative rainfall energy and the rainstorm intensity. (Author's abstract) ty. (Author's abstract) W91-02878

ANALYTICAL TRAVELING WAVE SOLU-TIONS FOR TRANSPORT WITH NONLINEAR AND NONEQUILIBRIUM ADSORPTION.

AND NONEQUILIBRIUM ADSORTION.
Agricultural Univ., Wageningen (Netherlands).
Dept. of Soil Science and Plant Nutrition.
S. E. A. T. M. Van der Zee.
Water Resources Research WRERAQ, Vol. 26,
No. 10, p. 2563-2578, October 1990. 8 fig, 1 tab, 56 ref, append.

Descriptors: \*Adsorption, \*Equilibrium, \*Ground-water movement, \*Path of pollutants, \*Soil chem-istry, \*Soil porosity, \*Soil water, \*Solute trans-port, Kinetics, Mathematical models, Sorption, Traveling wave, Wave velocity.

Transport was modeled for a soil with dual porosi-ty, or with chemical nonequilibrium, assuming first-order kinetics. The equilibrium sorption equa-tion in the immobile region is nonlinear. The Lang-muir and the Van Bemmelen-Freundlich equations were considered for sorption. The sorption equa-

tion in the mobile region is assumed to be linear. tion in the mobile region is assumed to be linear. Analytical solutions were obtained for the travel-ing wave displacement found for initial resident concentrations that are smaller than the feed con-centrations and for infinite displacement times, ne-glecting the coupled effects of dispersion and non-equilibrium conditions. These waves travel with a equilibrium conditions. These waves travel with a fixed shape and a fixed velocity through the homogeneous flow domain. Differences with respect to the linear sorption case are the smaller front thickness and the non-Fickian type of displacement. The non-Fickian behavior is intrinsic to the traveling wave assumption as the front does not spread with the square root of time. The analytical solutions obtained for the equilibrium and for the nonequilibrium situations are mathematically equivalent. Only the effective diffusion/dispersion coefficient. ordan stuations are materianciary equivalent.
Only the effective diffusion/dispersion coefficient needs to be adapted to account for nonequilibrium effects, as for linear dual-porosity models. Apart from early time behavior, the traveling wave solutions agree well with numerical approximations. The front steepness depends on the degree of nonlinearity. The sensitivity on the dispersion coeffi-cient and first-order rate coefficient may be large but depends on which mechanism controls front spreading. (Author's abstract) W91-02882

OBSERVATIONS ON THE DEVELOPMENT OF PORE-WATER STRESSES DURING PIE-ZOCONE PENETRATION IN CLAYS.

Cornell Univ, Ithaca, NY. School of Civil and Environmental Engineering. For primary bibliographic entry see Field 7B. W91-02938

CONTAMINANT MIGRATION THROUGH FRACTURED TILL INTO AN UNDERLYING

AQUIFER.
University of Western Ontario, London. Geotechnical Research Centre.
For primary bibliographic entry see Field 5B.
W91-02941

### 2H. Lakes

EFFECTS OF CALCIUM AND PH ON THE REPRODUCTIVE SUCCESS OF AMNICOLA

REFRUDIUCTIVE SUCCESS OF AMNICOLA LIMOSA (GASTROPODA).
Guelph Univ. (Ontario). School of Engineering. For primary bibliographic entry see Field 5C. W91-02064

DISTRIBUTION OF SHRIMP AND FISH BY-CATCH ASSEMBLAGES IN THE CANADIAN EASTERN ARCTIC IN RELATION IN WATER CIRCULATION.

Arctic Biological Station, Ste. Anne de Bellevue (Ouebec).

For primary bibliographic entry see Field 2L. W91-02066

RECIPROCAL DIEL VERTICAL MIGRATION BEHAVIOR IN PLANKTIVORES AND ZOO-PLANKTON IN BRITISH COLUMBIA LAKES. Department of Fisheries and Oceans, V (British Columbia). West Vancouver Lab.

(British Countries), 5 Ca. D. A. Levy, Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 9, p 1755-1764, September 1990. 7 fig, 51 ref.

Descriptors: \*Crustaceans, \*Diurnal variation, \*Ecosystems, \*Fish behavior, \*Lakes, \*Limnology, \*Migration, \*Predation, \*Salmon, \*Vertical distribution, \*Zooplankton, British Columbia.

Simultaneous comparison of planktivore and crus-Simultaneous comparison of planktivore and crus-tacean zooplankton distribution patterns in a set of British Columbia lakes suggested coupled diel ver-tical migration behavior in the two adjacent troph-ic levels. In lakes where juvenile sockeye salmon performed diel vertical migrations, most zooplank-ton were non-migratory and concentrated in shal-low surface waters over the diel cycle. In contrast, in one lake where pelagic threespine sticklebacks were present, and where juvenile sockeye diel

### Field 2—WATER CYCLE

### Group 2H-Lakes

vertical migrations were periodically reversed, most zooplankton undertook diel vertical migra-tions. The presence of diel vertical migration behavior in zooplankton thus appears to be related to the presence or absence of the behavior in the predominant planktivores. (Author's abstract)

OCCURRENCE, RELATIVE ABUNDANCE, AND SIZE OF LANDLOCKED SEA LAMPREY (PETROMYZON MARINUS) AMMOCOETES IN RELATION TO STREAM CHARACTERISTICS IN THE GREAT LAKES.

Department of Fisheries and Oceans, Sault Ste. Marie (Ontario). Great Lakes Lab. for Fisheries

Marie (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.

R. J. Young, J. R. M. Kelso, and J. G. Weise.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 9, p 1773-1778, September 1990. 2 fig, 4 tab, 38 ref.

Descriptors: \*Eel, \*Fishkill, \*Great Lakes, \*Lamprey, \*Streambeds, Correlation analysis, Discriminant analysis, Gravel, Sand, Substrates, Water tem-

The sea lamprey is of economic importance to the Great Lakes because it parasitizes salmonids and other game species resulting in significant mortality. The effect of 14 environmental variables on the occurrence of sea lamprey (Petromyzon marinus) ammocoetes was examined in 73 tributaries of the Great Lakes. We successfully classified 86% of streams without lamprey and 90.5% of streams without lamprey and 90.5% of streams with ammocoete populations using discriminant analysis. Eighty percent of streams in a test data set were also successfully classified. The classification success was largely determined by differences in success was largely determined by differences in stream substrate characteristics based on the magstream substrate characteristics based on the magnitude of canonical coefficients and contribution to the multivariate F-statistic. Streams with ammocoetes had a significantly (P < 0.10) higher proportion of sand and a lower proportion of bedrock and clay than streams without ammocoetes. Catch and cray than streams without ammooretes. Carlo per unit effort of ammooretes collected with elec-trofishing gear was also significantly related (P = 0.004) to the proportion of rubble, gravel, and clay. A significant (P < 0.01) positive relationship exist-A significant (F < 0.01) positive relationship existed between conductivity and temperature with size of 2+ ammocoetes. Results indicate that predictions could be developed for the number of metamorphosing ammocoetes based upon substrate differences in stream characteristics. (Author's ab-

RATIOS IN AQUATIC SCIENCES: STATISTI-CAL SHORTCOMINGS WITH MEAN DEPTH AND THE MORPHOEDAPHIC INDEX. Toronto Univ. (Ontario). Dept. of Zoology. For primary bibliographic entry see Field 7C. W91-02069

MEASURING EPILITHIC BACTERIAL PRO-DUCTION IN STREAMS. Guelph Univ. (Ontario). Dept. of Zoology. J. Hudson, J. C. Roff, and B. K. Burnison. Canadian Journal of Fisheries and Aquatic Sci-ences CJFSDX, Vol. 47, No. 9, p 1813-1820, Sep-tember 1990. 4 fig, 1 tab, 30 ref.

Descriptors: \*Bacteria, \*Data acquisition, \*Ecosystems, \*Lotic environment, \*Productivity, \*Sampling, \*Streams, Bacterial physiology, Metabolism, Riffles, Stream biota, Temporal variation.

Techniques have been developed for the measure-ment of bacterial production (by the rate of tritiat-ed thymidine and disturbance artifacts (TdR) incorporation into DNA), isotope dilution, time course of incorporation of nucleoside, and disturbcourse of incorporation of nucleoside, and disturbance artifacts in natural epilithic communities of headwater streams. The epilithon in riffles was subsampled by carefully chipping upper rock surfaces. Chips were placed in test tubes and incubated in situ. Test tubes were rotated to reduce the formation of artificial diffusion barriers to TdR transport. DNA was isolated using a double filtration technique. Summertime production had a range of 1.3 to 51 mg carbon/sq m/hr in five

southern Ontario streams. Precursors to DNA synsouthern Ontario streams. Precursors to DNA synthesis, which diluted tritiated TdR, had a range of 63 to 440 nM. Incorporation of tritiated TdR was linear for at least one hour. Disturbance artifacts did not appear from rock chipping or from extended sample rotation. The techniques can be applied to other microbial groups from various aquatic hard substrata. (Author's abstract) W91-02070

EFFECTS OF IRON CYCLING ON PB-210 DATING OF SEDIMENTS IN AN ADIRON-DACK LAKE, USA. Syracuse Univ., NY. Environmental Engineering

For primary bibliographic entry see Field 2J. W91-02071

MICROGRAZER IMPACT AND SUBSTRATE LIMITATION OF BACTERIOPLANKTON IN LAKE MICHIGAN.

National Oceanic and Atmospheric Administra-tion, Ann Arbor, MI. Great Lakes Environmental Research Lab.

G. L. Pernie, D. Scavia, M. L. Pace, and H. J. Carrick.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 9, p 1836-1841, September 1990. 5 fig, 3 tab, 27 ref.

Descriptors: \*Aquatic bacteria, \*Bacteria, \*Food chains, \*Lake Michigan, \*Limnology, \*Plankton, Bacterial physiology, Growth rates, Organic carbon, Predation, Substrates.

The roles of both heterotrophic and autotrophic picoplankton in aquatic food webs are increasingly recognized as ecologically important. Lake Michigan epilimnetic heterotrophic bacterial loss rates, predator size, and substrate limitation was estimated in 1986 and 1987. The bacterial growth rates the processing substrate additional processing subst were always enhanced by organic substrate addi-tions indicating that bacterial growth is limited, to some degree, by substrate availability. Loss rates and growth rates between 0.32 and 1.45 per day and growth rates between 0.32 and 1.45 per day were obtained. The grazers were predominantly picoplankton-size organisms, presumably heterotrophic flagellates. Using radiolabeled bacteria, only a small percentage (2 to 3%) of bacterial cells were incorporated into larger size fractions after 24 hours. These results indicate that heterotrophic bacteria were not a direct, significant, carbon source for the upper trophic levels. (Author's abstract) W91-02072

LARGE-LAKE RESPONSES TO DECLINES IN THE ABUNDANCE OF A MAJOR FISH PLANKTIVORE-THE LAKE MICHIGAN EX-

Michigan Univ., Ann Arbor. Center for Great Lakes and Aquatic Sciences.

M. S. Evans.

na. G. Evellis. Charles and Aquatic Sciences CJFSDX, Vol. 47, No. 9, p 1738-1754, September 1990. 10 fig, 41 ref.

Descriptors: \*Alewife, \*Algal control, \*Fish populations, \*Food chains, \*Lake Michigan, \*Lake restoration, \*Limnology, Aquatic plants, Biomass, Copepods, Phytoplankton, Predation, Seasonal variation, Water transparency, Waterfleas, Zoonlankton, plankton.

Alewife abundances declined dramatically in southeastern Lake Michigan over 1973 to 1977, several years before the lakewide decline occurred. several years before the lakewide decline occurred. The regional effects of this decline on adult copepod abundances, zooplankton biomass, and water clarity were investigated. In the offshore region, the two largest copepods, Limnocalanus macrurus and Diaptomus sicilus, increased in abundance during the mid-1970's reflecting the decrease in alewife predation. L. macrurus abundances declined in later years, reflecting increased predation pressures from the increasing bloater population. The small-bodied D. minutus and the mediumbodied D. ashlandi exhibited no apparent response to the decline in alewife abundance. Large-bodied D. oregonensis and small-bodied Calanus bicuspi-

datus thomasi declined in abundance. Size-selective fish predation pressures continued to remain high this predation pressures continued to remain nigh in the inshore region; increased abundance of yellow perch and rainbow smelt apparently com-pensated for the alewife decline. Zooplankton bio-mass, zooplankton mean dry weight, and water clarity apparently were not affected by the decline in alewife abundance in either the inshore or offshore regions. The results were evaluated in terms of the lakewide decline in alewife abundance, the summer 1983 dominance of Daphnia pulicaria in offshore waters, the 1983 marked improvement in offshore waters, the 1983 marked improvement in offshore water clarity, and later changes in summer offshore D. pulicaria populations, and suggest that phytoplankton control strategies should not be based solely on top-down management strategies. Moreover, top-down management strategies are probably more useful for moderately productive than for eutrophic systems and for small lakes rather than large and ecologically complex systems such as the Great Lakes. (Author's abstract) W91-02073

LAKE ACIDIFICATION AND FISHERIES PROJECT: BROOK TROUT (SALVELINUS FONTINALIS) EARLY LIFE STAGES.

Wyoming Univ., Laramie. Fish Physiology and

For primary bibliographic entry see Field 5C.
W91-02102

MODELLING PHYTOPLANKTON PRODUC-TIVITY IN TURBID WATERS WITH SMALL EUPHOTIC TO MIXING DEPTH RATIOS. Orange Free State Univ., Bloemfontein (South Africa). Dept. of Botany. J. U. Grobbelaar.

Journal of Plankton Research JPLRD9, Vol. 12, No. 5, p 923-931, September 1990. 4 fig, 1 tab, 18

Descriptors: \*Algae, \*Algal growth, \*Aquatic productivity, \*Light penetration, \*Limnology, \*Mathematical models, \*Model studies, \*Phytoplankton, \*Turbidity, Euphotic zone, Light quality, Mixing depth, Photosynthesis, Prediction, Respiration, Turbid water

A model which was developed and calibrated for predicting algal growth in mass cultures was modified for natural systems. In turbid systems, the ratio fied for natural systems. In turbid systems, the ratio of euphotic to aphotic depth is usually small and mixing may exceed the compensation depth. In order to compensate for the various light regimes to which the phytoplankton would be subjected, the losses due to dark respiration were modified so that the effective light history would determine the actual rate. The efficiency of light utilization also changes under different light regimes and the model was modified to take these variations into seconds. Both of these modifications resulted in model was modified to take these variations into account. Both of these modifications resulted in different production profiles being generated for the same surface conditions, but with different mixing depths, where the phytoplankton become more efficient as the light regime deteriorates (i.e. less respiration and greater light utilization efficienress respiration and greater light utilization efficiency). A further consequence is that the 'critical mixing depth' is approximately 2.5 times greater than that which was previously accepted, being about 20 times the euphotic depth. The model predicted productivities to within 90% of observed rates. The predictions could also be used to deter-mine the extent of nutrient limitation. The predicmine the extent of nutrient limitation. In a predictions have biomanipulatory consequences, as alterations of the light regime through the addition of non-photosynthesizing materials, under certain conditions, may even result in a stimulation of phytoplankton productivity. (Author's abstract) W91-02115

PHOTOTAXIS IN DAPHNIA MAGNA: THE IN-FLUENCE OF TEMPERATURE AND ACIDITY ON THE PHOTOTACTIC BEHAVIOUR OF DAPHNIA GENOTYPES.

Ghent Rijksuniversiteit (Belgium). Inst. of Animal

J. Van Uytvanck, and L. De Meester.

Journal of Plankton Research JPLRD9, Vol. 12,

Lakes-Group 2H

No. 5, p 1089-1097, September 1990. 3 fig. 5 tab, 23 ref. State University of Ghent Grant 01.1905.85.

Descriptors: \*Acid rain effects, \*Acidity, \*Animal behavior, \*Aquatic animals, \*Light effects, \*Limnology, \*Temperature effects, Daphnia, Genotypes, Hydrogen ion concentration, Phototaxis, Thermal stress, Water temperature, Watersleas.

The influence of culture temperature, temperature shocks and pH shocks on the phototactic behavior snocks and pH shocks on the phototactic behavior of four Daphnia magna clones was studied. Test animals tended to become more positively phototactic when the pH of the medium was raised, in the pH range of 6 to 9. D. magna clones were less positively phototactic when cultured at high (27 C) temperature. Responses to temperature changes at the start of the averaginant ware close despedate. temperature. Responses to temperature changes at the start of the experiment were clone-dependent. Only substantial temperature shocks (>10 C) seemed to alter the phototactic behavior significantly. Differences between genotypes remained highly significant despite the broader environmental conditions in which experiments were carried out. Broad heritability estimates for the phototactic behavior of Daphnia under the different environmental conditions studied ranged from 0.78 to 0.88. (Author's abstract) (Author's abstract) W91-02117

ATTACHED AND FREE-LIVING DIVIDING BACTERIA IN TWO AQUATIC SYSTEMS, Universidad del Pais Vasco, Bilbao (Spain). Dept.

de Microbiologia e Inmunologia.

J. Iriberri, M. Unanue, B. Ayo, I. Barcina, and L.

Egea. Letters in Applied Microbiology LAMIE7, Vol. 11, No. 2, p 87-89, August 1990. 2 tab, 7 ref.

Descriptors: \*Aquatic bacteria, \*Bacterial physiology, \*Coastal environment, \*Marine bacteria, Biomass, Butron River, Dissolved organic carbon, Growth rates, La Salvaje Beach, Nutrients, Organic carbon, Particulate matter, Rivers, Spain, Viz-

The percentage of dividing biomass was calculated for attached and free-living bacteria in a coastal marine system (La Salvaje Beach, Vizcaya, Spain) and a freshwater system (Butron River, Vizcaya, Spain). In the marine system, which had low average concentrations of total and dissolved organic carbon (1.7 mg/L TOC and 1.4 mg/L DOC), the percentage of dividing biomass was higher for attached (41.4 +/-13.9%) than for the free-living bacteria (22.0 +/-11.7%). However, in the freshwater system, which had mean concentrations of 11.6 mg/L TOC and 9.8 mg/L DOC, the percentage of dividing biomass was similar for both compared to the compared to the statement of the compared to the com age of dividing biomass was similar for both communities: attached, 53.4 +/-26.5%; free-living, 78.4 +/-21.9%. Thus the attachment to particulate material is not necessarily an advantage in waters where dissolved organic nutrients are readily available. (Author's abstract) W91-02121

MODELLING ENVIRONMENTAL SCENARIOS IN PONDS.

Bayreuth Univ. (Germany, F.R.). Chair of Ecological Chemistry and Geochemistry.
For primary bibliographic entry see Field 7C.
W91-02176

VARIABILITY IN CONCENTRATIONS OF SE-LECTED TRACE ELEMENTS IN WATER AND SEDIMENT OF SIX ACIDIC LAKES. Cook Coll., New Brunswick, NJ. Dept. of Envi-ronmental Science.

For primary bibliographic entry see Field 5B. W91-02193

POPULATION-SPECIFIC TOXICITY RE-SPONSES BY THE FRESHWATER OLIGO-CHAETE, STYLODRILUS HERINGIANUS, IN NATURAL LAKE MICHIGAN SEDIMENTS.

National Oceanic and Atmospheric Administra-tion, Ann Arbor, MI. Great Lakes Environmental Research Lab.

bibliographic entry see Field 5C.

HYDROLOGY OF GOAT LAKE WATERSHED, SNOHOMISH COUNTY, WASHINGTON, 1982-

Geological Survey, Tacoma, WA. Water Re-For primary bibliographic entry see Field 5B. W91-02227

ESTIMATES OF GROUND-WATER FLOW COMPONENTS FOR LYMAN LAKE, APACHE COUNTY, ARIZONA, WITH A SECTION ON GEOCHEMISTRY OF SURFACE WATER AND GROUND WATER IN THE LYMAN LAKE AREA BY FREDRICK N. ROBERTSON. Geological Survey, Tucson, AZ. Water Resources

For primary bibliographic entry see Field 2F. W91-02231

SUMMARY OF BIOLOGICAL INVESTIGA-TIONS RELATING TO SURFACE-WATER QUALITY IN THE KENTUCKY RIVER BASIN,

Geological Survey, Reston, VA. Water Resources

For primary bibliographic entry see Field 5C. W91-02232

FATHOMETER DATA FROM BART LAKE AND LAKE DOROTHY NEAR JUNEAU, ALASKA, 1988-89. Geological Survey, Anchorage, AK. Water Re-

sources Div. For primary bibliographic entry see Field 7C. W91-02254

DIEL AND SEASONAL ENERGY TRANSFER, STORAGE AND STRATIFICATION IN AFRICAN RESERVOIRS AND LAKES. Biological Association, Ambleside

(England). J. F. Talling. Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 651-660, 1990. 5 fig. 34 ref.

Descriptors: \*Africa, \*Energy transfer, \*Heat storage, \*Lakes, \*Limnology, \*Reservoirs, \*Thermal stratification, Diurnal variation, Humidity, Lake evaporation, Seasonal variation, Tropical regions, Water temperature.

Relationships between water temperature, heat storage, and other components of the energy budget for African reservoirs and lakes were sur-veyed. The seasonal variations of surface tempera-ture and incident short-wave solar radiation are broadly correlated in a latitudinal series, with minimum amplitude and phase reversal near the equa-tor. Some divergences can be related to changes of tor. Some divergences can be related to changes of the evaporative (latent heat) flux density, condi-tioned by seasonally altered humidity and wind regime. Within the tropics there is a close relation-ship between bottom temperature and altitude, as yet unsupported by finer physical analysis. The resolution of component flux densities in the diel energy budget is illustrated by three examples from work on Lake Chad and a Nile reservoir. For the latter, the residual ascribed to diel heat storage was broadly consistent with observed rates of heat storlatter, the residual ascribed to diel heat storage was broadly consistent with observed rates of heat storage, although these also suffered irregularities from horizontal advection. Such diel heat storage is ecologically influential, through induced thermal stratification, in many African water bodies. Its magnitude is compared, across a range of latitudes, with the much larger amplitude of annual heat storage. (Author's abstract)
W91-02370

LIMNOLOGY AND EUTROPHICATION OF BARRA BONITA RESERVOIR, S. PAULO STATE, SOUTHERN BRAZIL. Sao Paulo Univ., Sao Carlos (Brazil). Escola de

Sato Tauto Univ., Sato Cartos (Bazil), Escola de Engenharia. J. G. Tundisi, and T. Matsumura-Tundisi. Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 661-676, 1990. 16 fig, 26 ref.

Descriptors: \*Barra Bonita Reservoir, \*Brazil, \*Eutrophication, \*Limnology, \*Phytoplankton,

\*Reservoirs, \*Water pollution effects, \*Zooplank-ton, Chlorophyll, Flushing, Nitrogen, Phosphorus, Primary productivity, Rainfall, Reservoir sedi-ments, Residence time, Thermal stratification,

Limnological studies coupled with climatological Limnological studies coupled with climatological measurements were made in the Barra Bonita reservoir, Brazil. One year of sampling showed a pattern in which main forcing functions were rainfall, wind, flushing rate, and residence time. Summer months were characterized by short water residence time (one month) while in the autumn, winter and spring periods the residence time was higher (six months). The seasonal cycle of phytoplankton biomass and composition, primary production and nutrient cycles are controlled by the coupling of the above four factors. The reservoir is polymicite with short periods of stratiby the coupling of the above four factors. The reservoir is polymictic with short periods of stratification. Primary production ranges from 200 to 800 mg C/sq m/day. The phytoplankton change from a flagellate/diatom community to a diatom/blue green one during periods of long residence time. Chlorophyll values range from 5 to 238 micrograms/L during heavy blooms. Concentration of phosphorus is maintained at low levels due to continuous circulation and precipitation to the sediment. Nitrogen is not limiting for phytoplankton production. Cyclopoida dominate over the Calanoida in the zooplankton community, a fact that confirms the eutrophic nature of the reservoir. Adequate treatment along with the introduction of confirms the eutrophic nature of the reservoir. Adequate treatment along with the introduction of periods with lower or higher discharge coupled with the hydrologic cycle and flushing rate is an important step in the management of this reservoir. Nutrient reduction could also be achieved by aeration of the tributaries that are major sources of P inflow, increasing the through-flow of spill water during the rainy season thus eliminating possible phytoplankton concentrations, and introducing artificial mixing in the main channel. Other techniques would include reduction of the bottom deposits of sediments and organic matter at intake structures for the turbines in deep water, and land use practices such as protection zones, application use practices such as protection zones, application of fertilizers, crop rotation, and spoil stabilizing tillage techniques. (Author's abstract)

ANNUAL AND LONGITUDINAL CHANGES IN THE ENVIRONMENTAL CONDITIONS IN THREE CONSECUTIVE RESERVOIRS OF THE GUADIANA RIVER (W. SPAIN).

Barcelona Univ. (Spain). Dept. de Ecologia. J. Armengol, F. Sabater, J. L. Rierra, and J. A. Morgui.

Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 679-687, 1990. 4 fig. 2 tab, 15 ref. Comision Aserora de Investigation Científico y Tecnica, Programa PB85-0166.

Descriptors: \*Environmental gradient, \*Guadiana River, \*Limnology, \*Multireservoir networks, \*Reservoirs, \*Spain, Alkalinity, Chemical properties, Chlorides, Chlorophyll a, Conductivity, Flow, Hydrogen ion concentration, Nitrates, Nitrites, Oxygen, Phosphates, Physical properties, Principal component analysis, Seasonal variation, Secchi disks, Sulfides, Water temperature.

Temporal and longitudinal changes in the environ-mental conditions in a cascade of three reservoirs on the Guadiana River (Spain) were studied. Phys-ical and chemical parameters were used to characical and chemical parameters were used to characterize longitudinal patterns of change: conductivity, Secchi disk, pH, alkalinity, temperature, oxygen, nitrate, nitrite, phosphate, chloride, sulfide, monthly water, flow volume, water speed and chlorophyll a. Temporal heterogeneity along two years with different climatic conditions was also considered. By means of principal component analysis (PCA) a gradient analysis was performed using the scores of each sampling point in the space defined by the first three principal axes. The first principal component axis was strongly correlated with a group of variables that jointly determine the salinity of the water and can be simply be expressed as conductivity. In Guadiana reservoirs, expressed as conductivity. In Guadiana reservoirs, salinity/conductivity are a consequence of water inputs from the endorreic upstream catchment. The variables more correlated with the second axis

### Field 2-WATER CYCLE

### **Group 2H—Lakes**

were represented by water temperature and varied according to a seasonal cycle. The third principal component represented the average and annual pattern of spatial evolution produced by the combination of physical, chemical, and biological processes taking place along the main axis of the reservoirs. The results demonstrate three levels of temporal and spatial organization: (1) annual changes common to the three reservoirs-PCA axes 1 and 2, (2) differences among reservoirs-PCA axis 1, and (3) differences among stations inside each reservoir-PCA axis 3. (Author's abstract) W91-02372

CLIMATE AND CLIMATIC RESOURCES OF

CLIMATE AND CLIMATIC RESOURCES OF RESERVOIRS.
Limnologicheskii Inst., Irkutsk (USSR).
N. P. Ladeishchikov, and V. A. Obolkin.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 689-693, 1990. 1 tab, 7 ref.

Descriptors: \*Climatology, \*Environmental effects, \*Lakes, \*Limnoclimatology, \*Reservoirs, Air pollution, Air temperature, Heat budget, Limnology, Model studies, Precipitation, Recreation, Siberia, USSR.

A model of reservoir limnoclimate can be represented as a function of: (1) the thermal flow at the reservoir surface; (2) the thermal capacity of the reservoir; (3) the loss of heat from the reservoir surface to the atmosphere; (4) moisture exchange between the atmosphere and the lake; (5) the intensity of local circulation exchange in the reservoir's coastal zone; (6) the degree of orographic isolation; and (7) the intensity of macroadvection over the reservoir. The relative stability of a reservoir's limnoclimate stabilizes its ecological surroundings against the external influences of seasonal and secular variations of climate. Therefore, limnoclimate must be considered along with other factors in the creation and development of reservoirs. A comparison of mean air temperature and atmospheric precipitation in the region of three Siberian reservoirs A model of reservoir limnoclimate can be repreison of mean air temperature and atmospheric pre-cipitation in the region of three Siberian reservoirs before and after reservoir formation indicates that reservoirs significantly influence the climate. The reservoirs and lakes have a smoothing effect on the climate of surrounding areas, lowering the ampli-tude of both daily and annual temperature and precipitation variations. The climatic effect (cool-ing in summer) of these Siberian reservoirs causes some aggravation of atmospheric pollution over their surfaces due to an increase in inversion fre-quency and a decrease of topographic relief. On the other hand, reservoir areas have greater overall atmospheric clarity, less weather severity and varithe other hand, reservoir areas have greater overaint atmospheric clarity, less weather severity and vari-ability, and longer-lasting periods of favorable me-teorological conditions than comparable continen-tal regions. The construction of man-made resertai regions. The construction of man-made reservoirs results in a wide variety of recreation resources in both the reservoir and its surroundings. This recreational potential is enhanced by the climatic amelioration. (Sand-PTT) W91-02373

LONG-TERM TRENDS IN THE SESTON CON-TENT OF A SHALLOW EUTROPHIC LAKE AND SOME RELATIONS TO CLIMATIC ELE-MENTS.

MENIS.
Institute of Geography and Geoecology, Berlin (German D.R.). Dept. of Hydrology.
R. Stellmacher.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 695-699, 1990. 2 fig. 1 tab, 10 ref.

Descriptors: \*Algae, \*Climatology, \*Eutrophic lakes, \*Limnology, \*Seston, Air temperature, Germany, Lake Muggelsee, Population dynamics, Regression analysis, Seasonal variation, Thermal radiation. Time series analysis.

Seasonal time series of the buoyant part of the seston content of Lake Muggelsee, the sums of negative daily mean temperatures in Berlin, and the global radiation in Potsdar aue been collected for as long as 50 years. The structure of these time series and the relationships between them were investigated. The series are characterized by more or less strong cyclic variations of from 2 to 24 years. A moving spectral estimation of daily mean temperatures gives an idea of the change of

spectral behavior over time: in the past, periodicities of about 3.4, 5, and 10 years dominated, but at present there are cycles of about 2.3 and 7 years. Regression analysis showed that winter severity influences only the starting phase of algal develop-ment. It was concluded that monthly values are nent. It was concluded that frontiny values are not sufficient to describe causal relations between seston content and the population dynamics of individual algal species; shorter average periods are necessary. However, monthly, seasonal, and annual values are useful for determining correlations between more general entities such as the buoyant part of seston and certain climatic elets. (Author's abstract)

BIOLOGICALLY AVAILABLE PHOSPHORUS RETENTION BY THE KIS-BALATON RESERVOIR.

Ulster Univ., Coleraine (Northern Ireland). Lim-

J. Zlinsky, and S. Herodek. Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 703-707, 1990. 3 fig. 1 tab, 10 ref.

Descriptors: \*Eutrophication, \*Limnology, \*Nu-Descriptors: "Eutrophication, "Liminology, "rutient transport, "Path of pollutants, "Phosphorus, "Reservoirs, "Water pollution control, Algal blooms, Cyanophyta, Hungary, Lake Balaton, Phytoplankton, Wastewater treatment, Zala River.

The largest tributary of Lake Balaton, the River Zala, discharges 50 tons of dissolved phosphorus (DP) and 40 tons of particle-bound phosphorus (PP) per year, causing serious eutrophication of the westernmost basin of the lake. To complement other measures of water quality protection in the catchment area, the shallow reservoir Kis-Balaton was built to reduce the nutrient load and prevent silting. The changes in the concentration and rela-tive importance of P fractions entering and leaving the reservoir were investigated. The dissolved bio-logically available P (BAP) concentrations usually equal the soluble reactive P (SRP). The non-reacequal the soluble reactive P (SRP). The non-reactive DP concentration remained unchanged along the river. Winter experiments showed a PP and a total dissolved P (TDP) retention of 87% and 49%, respectively, giving a total P (TP) retention of 70%. The availability of the effectively withheld PP proved to be only 17-19%, lowering the overall BAP retention to 60% of the TP. During overall BAP retention to 60% of the TP. During the summer there were blue-green algal blooms in the reservoir. The P uptake of the phytoplankton increased the TDP and SRP retention to 74% and 86%, respectively, but there was more PP leaving the reservoir than entering it. At the lowest reach of the River Zala, the significant increase of dissolved BAP and PP concentrations indicates important sources of pollution. The major part of P leaving the reservoir in readily available dissolved forms originates from sewage. The contribution of diffuse P loading (like soil erosion in the watershed) to eutrophication is much less than that of the sewage plants, if judged with respect to BAP rather than to TP measurements. Eutrophication models suggest that to prevent the algal blooms, rather than to TP measurements. Eutrophication models suggest that to prevent the algal blooms, the BAP loading should be reduced by 75%. Considering the higher availability and lower retention rate of sewage P, tertiary treatment plants both upstream and downstream of the reservoir seem to be the most effective investment to achieve this goal. (Sand-PTT) W91-02375

PHOSPHORUS CYCLE AND ITS SIGNIFI-CANCE IN THE EUTROPHICATION OF LAKE

Akademiya Nauk Armyanskoi SSR, Sevan. Hydrobiological Station.
For primary bibliographic entry see Field 5C.
W91-02376

PELAGIC CALCITE PRECIPITATION AND TROPHIC STATE OF HARDWATER LAKES, Akademie der Wissenschaften der DDR, Berlin Zentralinstitut fuer Mikrobiologie und Experimen-R. Koschel.

Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 713-722, 1990. 3 fig, 2 tab, 56 ref.

Descriptors: \*Calcite precipitation, \*Calcium carbonate, \*Hardness, \*Hardwater lakes, \*Limnology, \*Trophic level, Chlorophyll, Eutrophication, Germany, Phosphorus, Phytoplankton.

The CaCO3 concentration of different hardwater lakes of the Mecklenburg District was analyzed and related to trophic conditions. The results indicate that calcite precipitation is associated with coreactions which play a fundamental role in self-purification of the lakes. High calcite precipitation coreactions which play a fundamental role in self-purification of the lakes. High calcite precipitation provides a high autochthonous self-protection potential and helps counteract eutrophication. The relation between the chlorophyll a content of the phytoplankton and the total phosphorus content is a sigmoid function in the lakes examined. This sigmoid character is lost in stratified hardwater lakes. The calcite precipitation causes the phytoplankton biomass to be reduced during the summer stagnation period. Calcite precipitation slows up eutrophication and diminishes the exponential increase in phytoplankton biomass in relation to phosphorus supply. The regulation of trophic state is obviously different for hardwater lakes and softwater lakes. Therefore, for lakes with a high temporary hardness (with calcite precipitation), classification of trophic state, especially in terms of the phosphorus and phytoplankton biomass, should be performed differently from classification of those with a low temporary hardness (without calcite precipitation). (Sand-PTT) W91-02377

LONGITUDINAL DIFFERENTIATION AC-CORDING TO ENVIRONMENTAL FACTORS AND PHYTOPLANKTON IN ARACENA AND LA MINILLA RESERVOIRS (SEVILLA,

Seville Univ. (Spain). Faculty of Biology.

J. Toja. Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 733-747, 1990. 7 fig, 4 tab, 12 ref.

Descriptors: \*Eutrophic lakes, \*Limnology, \*Phytoplankton, \*Reservoirs, \*Spain, Arecena Reservoir, Environmental gradient, Eutrophication, La Minilla Reservoir, Lake stratification.

The possible differentiation of the environmental characteristics and phytoplankton communities along the Aracena and La Minilla reservoirs was studied from April 1977 to May 1978. In each reservoir five sampling stations were studied. Ara-cena had a behavior similar to a lake and environmental factors and phytoplankton development both showed little difference among various zones of the reservoir. The characteristics of the samples depended on organism activity in response to processes linked to the mixed-stratification cycle. Howesses insked to the mixed-stratification cycle. How-ever, the secondary branch of the reservoir was a little more eutrophic than the primary branch, and summer conditions appeared there before they did at the other stations. La Minilla reservoir behaved more like a river and the water flow determined the characteristics of each zone. There was a differentiation between the environmental factors of the dam and river zones, but differences in the phytoplankton communities were not significant. (Author's abstract) W91-02379

LONG-TERM RELATIONSHIPS BETWEEN PHYTO- AND ZOOPLANKTON IN THE MESO-EUTROPHIC RESERVOIR SAIDEN-

Akademie der Wissenschaften der DDR, Leipzig. Hydrobiologisches Lab. W. Horn, and H. Horn.

Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 749-762, 1990. 12 fig, 2 tab, 23 ref.

Descriptors: \*Food chains, \*Limnology, \*Phyto-plankton, \*Population dynamics, \*Reservoirs, \*Zooplankton, Chlorophyta, Correlation analysis, Crustaceans, Cyanophyta, Daphnia, Diatoms, Ger-many, Limiting nutrients, Phosphorus, Saidenbach Reservoir, Seasonal variation, Secchi disks.

The variability and interactions of phytoplankton and zooplankton over seasons and years were in-

Lakes-Group 2H

terpreted from plankton samples taken at nearly weekly intervals for 11 years. The soluble reactive concentrations of the growth-limiting nutrient phosphorus underwent great variation, but no correlation with the phytoplankton could be detected. Strong interactions were found between phytoplankton and zooplankton. A direct and significant correlation became evident between the maximum epilimnetic biomass of crustacean zooplankton and colonial green algae, whose apparent indigestibility may protect them from grazing. A negative relationship existed between the epilimnetic biomasses of Asterionella, diatoms, and nanoplankton and the crustacean (Daphnia) biomass, indicating that high concentrations of herbivores are able to control these algae. No correlation could be found beconcentrations on nerrovores are able to control these algae. No correlation could be found be-tween crustacea and blue-green algae or Fragiliaria. Secchi-disk readings showed a weak positive rela-tionship to the crustacean biomass. The main result of this investigation was the evidence of strong interactions between phytoplankton and zooplankton over whole seasons. (Author's abstract) W91-02380

## FRY COMMUNITIES AS A BIOMANIPULAT-ING TOOL IN A TEMPERATE LOWLAND RESERVOIR. Lodz Univ. (Poland). Inst. of Environmental Biol-

ogy. M. Zalewski, B. Brewinska-Zaras, and P.

Frankiewicz.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 763-774, 1990. 5 fig, 1 tab, 40 ref.

Descriptors: \*Fish food organisms, \*Food habits, \*Perch, \*Reservoir fisheries, \*Reservoirs, \*Water quality, Daphnia, Growth, Phytoplankton, Poland, Reproduction, Sulejow reservoir, Water quality control, Zooplankton.

On the basis of a five-year study a high variability of the reproductive success of the dominant perch (Perca fluviatilis) and accompanying Cyprinidae species in the Sulejow Reservoir in central Poland was determined. Recruitment was significantly correlated with the water level and its stability. The main food component of perch fry was zooplankton; however, its proportion to other invertebrates varied from station to station. Zooplankton was most intensely consumed at dusk and night was most intensely consumed at dusk and night hours. During the year of highest perch density, their stomach fullness and percentage of eaten Daphnia drastically declined. In parallel the amount of phytoplankton remarkably increased. The feeding strategy of perch and the strong cor-relation between the density of the dominating perch fry and their growth rate, indicates their influence on the density of large zooplankton fil-terers, which determined water quality. (Author's abstract) W91-02381

PERIPHYTON AS INDICATOR OF THE RESERVOIR WATER QUALITY: III. BIOMONITORING TECHNIQUES.

Prague Dept. of Water Technology and Environmental Engineering (Czechoslovakia).

For primary bibliographic entry see Field 5A. W91-02382

## PREDICTION ON EUTROPHICATION OF RESERVOIR YUQIAO. Tianjin Inst. of Environmental Protection and Sci-

For primary bibliographic entry see Field 5G. W91-02383

### EUTROPHICATION OF NIGERIA'S LAKE

Benin Univ., Benin City (Nigeria). Dept. of Zoolo-

For primary bibliographic entry see Field 5C. W91-02384

#### CLASSIFICATION OF THE PRINCIPAL FRENCH RESERVOIRS.

Electricite de France, Paris. Direction de l'Equipe-

A. Gregoire. Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 807-818, 1990. 5 fig. 1 tab, 36 ref.

Descriptors: \*France, \*Lake classification, \*Lake morphology, \*Limnology, \*Reservoirs, Cluster analysis, Correlation analysis, Factor analysis, Water quality

To help forecast trends in the water quality of reservoirs, classification of 185 French reservoirs was carried out on the basis of their physical characteristics. The 22 abiotic characters used characteristics. The 22 about characters used were selected according to the importance placed on them in the literature to explain the biological structure of lake ecosystems. These variables were evaluated statistically. Correlation analysis showed evaluated statistically. Correlation analysis showed that these descriptive factors can be divided into five clusters: (1) factors describing inflow to the reservoir; (2) morphometric characteristics; (3) reservoir operating conditions; (4) technical specifications of the hydraulic machinery; and (5) qualitative data-catchment geology, geographic position, river regime, type of dam, reason for construction, etc. The automatic clustering of the reservoirs defines 7 principal types whose differences are explained by a multiple-correspondence factor analysis: (1) reservoirs on smaller streams, but situated far from the headwaters, and having major water-level fluctuations; (2) reservoirs on France's largest rivers, with minimal water-level fluctuations, and with current-powered generating plants; (3) deep reservoirs on the high-altitude headwaters of streams; (4) the largest reservoirs, characterized by a low water-mass renewal rate and great lake-(3) deep reservoirs on the high-altitude headwaters of streams; (4) the largest reservoirs, characterized by a low water-mass renewal rate and great lake-level fluctuation; (5 and 6) reservoirs 30 to 40 m deep, situated at moderate altitudes, and having important water-level fluctuations (these two types differ from one another in the amount of their inflow); and (7) reservoirs on the headwaters of small streams. (Sand-PTT)

WATER QUALITY IN CZECHOSLOVAK WATER-SUPPLY IMPOUNDMENTS.
Prague Dept. of Water Technology and Environmental Engineering (Czechoslovakia).

Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 819-825, 1990. 3 fig, 4 tab, 23 ref.

Descriptors: \*Czechoslovakia. \*Lake classification. \*Limnology, \*Reservoirs, \*Water quality criteria, Ecosystems, Environmental effects, Pollution index, Trophic level, Water supply.

The saprobic index and the trophic potential were used for the evaluation of water quality in Czecho-slovakian water-supply impoundments. Of 57 such reservoirs, sufficient data were available from 49 reservoirs, sufficient data were available from 49 for assignment of a saprobity/trophism rank. Four reservoirs were xenosaprobic or ultra-oligotrophic, 18 were oligosaprobic or oligotrophic, 16 were gamma-mesosaprobic or mesotrophic, 7 were beta-mesosaprobic or beta-eutrophic, and 1 was alpha-mesosaprobic or alpha-eutrophic. In addition, 3 impoundments fell between the oligosaprobic/oligotrophic and the gamma-mesosaprobic/mesotrophic categories. The water-quality criteria themselves were also evaluated in this study. Both criteria are quantitative ones and appropriate for serves were also evaluated in this study. Both criteria are quantitative ones and appropriate for such classifications. They are able to distinguish relatively weak differences in time and space for one ecological community as well as differences among various communities within the impoundamong various communities within the impound-ment. Both are not stable phenomena and their changes indicate fluctuations in the saprobic and trophic conditions, especially along longitudinal and vertical distributions. They react to environ-mental factors acting within and from outside the body of water. (Sand-PTT) W91-02386

# WATER QUALITY IN RESERVOIRS: THE EFFECT OF INFLOWING POLLUTION. Vyzkumny Ustav Vodohospodarsky, Prague (Czechoslovakia).

For primary bibliographic entry see Field 5B. W91-02387

CLASSIFICATION OF SOME RESERVOIRS IN SR SERBIA (SFR YUGOSLAVIA) BASED ON ANALYSIS OF PLANKTON SPECIES AS INDI-CATORS OF TROPHIC CONDITIONS.

Institute for Biological Research, Belgrade (Yugo-

V. Martinovic-Vitanovic, and V. Kalafatic. Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 831-837, 1990. 1 tab, 18 ref.

Descriptors: \*Bioindicators, \*Lake classification, \*Limnology, \*Plankton, \*Reservoirs, \*Trophic level, \*Yugoslavia, Eutrophication, Lentic environment, Nitrates, Nutrients, Phosphates.

During the last few decades, a number of reservoirs have been built in Serbia, creating new aquatic ecosystems with characteristics differing from those of the original river systems. This has resulted in the appearance of biotic assemblages specific to lentic waters, and completely different from those characteristic of flowing rivers. Changes have also occurred in the structure and composition of plankton communities, due to their adaption to the new environmental conditions. A qu tative and quantitative analysis of plankton was undertaken as an indication of the trophic status of several characteristic reservoirs. Measurements were made of concentrations of phosphates and nitrates--known chemical factors relevant to eutrophication. Based on their morphometric features, nutrient concentrations, and plankton populations, the six reservoirs studied can classified as lations, the six reservoirs studied can classified as to trophic type: Bor-oligotrophic; Bovan-oligotrophic-mesotrophic; Zaton-mesotrophic; Gruza-eutrophic; Sava Lake-eutrophic-hypereutrophic; Djerdap-hypereutrophic. It should be emphasized that concentrations of phosphates in the surface waters were generally high. Consequently, these values cannot serve as the only parameter defining organic production of an aquatic ecosystem, and classifying reservoirs solely by determining the concentrations of phosphates may produce erroneous conclusions regarding the trophic status. (Sand-PTT) W91-02388

### ECOLOGY OF LOWLAND ZEGRZYNSKI RESERVOIR NEAR WARSAW.

Polish Academy of Sciences, Lomianki. Inst. Ekologii.

Z. Kajak.

Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 841-850, 1990. 2 fig, 7 tab, 32 ref.

Descriptors: \*Limnology, \*Phytoplankton, \*Reservoirs, \*Seston, \*Trophic level, \*Zegrzynaki reservoir, \*Zooplankton, Nitrogen, Phosphates, Phosphorus, Poland, Primary productivity, Secchi disks, Secondary productivity, Transparency,

The main parameters of the Lake Zegrzynski res-The main parameters of the Lake Zegrzynski reservoir are: length 70 km, surface area 33 sq km, average depth 3-4 m, and retention time 5-10 days. Two main inlets provide 58% and 42% of the total inflow, respectively; total P and seston (up to several times). The trophic status of the lake is severy high: Seechi disk transparency 0.7-1.3 m, total P 150-300 micrograms/L, phosphate-P 50-170 micrograms/L, total N 2.0-3.0 mg/L. Seston (mg dry weight/L) on the average from 40 in more polluted inlets to 9 at the dam, phytoplankton (mg freshed inlets to 9 at the dam, phytoplankton (mg freshed inlets to 9 at the dam, phytoplankton (mg freshed inlets to 9 at the dam, phytoplankton (mg freshed inlets to 9 at the dam, phytoplankton (mg freshed inlets to 9 at the dam, phytoplankton (mg freshed inlets to 9 at the dam, phytoplankton (mg freshed inlets to 9 at the dam, phytoplankton (mg freshed inlets to 9 at the dam, phytoplankton (mg freshed inlets to 9 at the dam, phytoplankton (mg freshed inlets to 9 at 10 at 1 ed inlets to 9 at the dam, phytoplankton (mg fresh wight/L) decreases from 30 to 8. Zooplankton biomass is higher (up to 10 mg/L) in standing portions of the reservoir, with rotifers more abunportions of the reservoir, with rotifers more abundant in the fluvial areas (up to 2 times). Benthos biomass is high, especially in middle lotic areas (up to 1.8 kg/sq m fresh weight), with mollusks being dominant (60-80%). The average biomass (g/sq m) in the middle and lower portions of the lake is 29.0 for phytoplankton, and 1000 for zoobenthos. The estimated annual production (g/sq m) is 2.9 for phytoplankton, 0.4 for zooplankton, and 1.5 for zoobenthos. The efficiency of lankton, puts benthes secondary production of plankton plus benthos secondary production ex-pressed as its ratio to seston load and primary production is rather high, 13.7%. (Author's ab-

### Group 2H-Lakes

INFLUENCE OF IMPOUNDMENTS ON PHY-TOSESTON BIOMASS OF TWO SMALL LOW-LAND RIVERS-SKIERNIEWKA AND RAWKA

Polish Academy of Sciences, Lomianki. Inst. Eko-

logii. A. T. Simm.

Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 851-860, 1990. 6 fig, 10 ref.

Descriptors: \*Biomass. \*Dam effects. \*Limnology. \*Phytoplankton, \*Rawka river, \*Seston, \*Skierniewka River, Algae, Diatoms, Dinoflagellates, Ecosystems, Flagellates, Poland, Population dynamics, Reservoirs, Rivers, Seasonal variation, Species composition, Strowbow Reservoir.

Phytoseston of the Skierniewka River can be defined as a community of planktonic species, typical for polluted rivers in moderate zone. Communities of Pennatae diatoms, typical for clear rivers, occur as the dominant species in the Strowbow Reservoir as the dominant species in the Strowood Reservoir upstream from the impoundments. In the Rawka River, in spite of the domination by planktonic species, significant participation of Pennatae dia-toms can be noticed, from a weak loading of wastewaters. In spring and autumn, centric dia-toms (mainly S. hantzschii) dominated in both the toms (mainly 5, natrestin) commared in both the Skierniewka and Rawka Rivers. During the summer, the biomass of diatoms decreases, chang-ing into Cylotella spp., Melosira spp., and green algae. In the Skierniewka River the important phytoseston participants were: cryptomonads, euglen-oids, and on the lower stretch of the river, bluegreen algae. In the Rawka River centric diatoms dominate in the summer. In both rivers, nannoplanktonic species dominated, but their participation decreased in the summer to 60% or less. The most intensive increase of nannoplankton participation was recorded in the largest reservoir in Skierniewice and in the impoundment in Myslakow, situated on the lower stretch of the Skierniewka River where the participation of large flagellates and blue-green algae has been increasing simulta-neously with the increase of river pollution. The Strobow (with a 2-7 day retention time) and Skierniewice (8-12 day retention time) Reservoirs had the highest increase in biomass. In the Strowbow Reservoir, a 20-40 times increase of biomass was observed in comparison with a control station situated 250 m downstream. In the Skierniewice Reservoir, the increase was 2-4 times lower, with a maximum of biomass. In reservoirs with retention times not longer than half a day (ie., the Myslakow and Suliszew), the biomass growth was low, and the decrease of phytoseston biomass was noted more often. The lower increase of phytoseston biomass in the impoundment at Skierniewice can be connected with too high a retention time, causing the growth of herbivorous zooplankton, and sedimentation of passively floating diatoms, that could clear up the domination of large flagellates during the summer. (Sand-PTT)

WATER QUALITY OF SOME RESERVOIRS. Vyzkumny Ustav Vodohospodarsky, Prague (Czechoslovakia). For primary bibliographic entry see Field 5A.

W91-02391

WATER QUALITY IN THE SANCE RESER-VOIR (NORTH MORAVIA). Ceskoslovenska Akademie Ved, Prague. Hydro-

biologicka Lab

For primary bibliographic entry see Field 5G. W91-02392

RELATING EMPIRICAL WATER QUALITY DIAGRAMS AND PLANKTON-DYNAMICAL MODELS: THE SAMPLE METHODOLOGY APPLIED TO A DRINKING WATER STORAGE

Rijksinstituut voor de Volksgezondheid, Utrecht (Netherlands).

For primary bibliographic entry see Field 5F. W91-02395

IMPORTANCE OF GEOGRAPHICAL ASPECTS IN ENVIRONMENTAL STUDIES OF HYDRO-QUEBEC RESERVOIRS.

C. Demers.

Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 913-918, 1990. 1 fig. 1 tab.

Descriptors: "Geography, "Geomorphology, "Hydroelectric power, "Limnology, "Quebec, "Reservoir operation, "Reservoirs, "Surveys, Acid rain, Canada, Erosion, Fertilizers, Floods, Geologic formations, Geologic history, Irrigation, Municipal wastewater, Navigation, Precipitation, Recreation, Social aspects, Stream fisheries, Wastewater discord.

In addition to the biological and water quality aspects, geographical considerations are important in providing a basis for environmental studies of reservoirs. For the case of Hydro-Quebec reservoirs, knowledge of the specific geographic context allows one to estimate the size and date of the text allows one to estimate the size and date of the spring flood, using the ratio between rain and snow precipitation, and thus to minimize the risks of flooding. Relationships can be established between sources of acid rain production, prevailing winds and the sites of reservoirs that may be subject to acidification, because of the geology of the subsoil. A definition of the territory in its physiographic regions and smaller sub-regions, as well as knowlregions and smaller sub-regions, as well as knowledge of its recent geological history and past and present geomorphological processes are essential and must be available at the start of a study program. Reservoirs located on a plateau, valley or plain will not have the same surface-to-depth ratio or the same ratio of original area to flooded area. Their shorelines will be differently defined and consist of different metrails, and subject to quite different dynamics. Access to tributaries by spawning fish will also be determined by the morphology. ing fish will also be determined by the morphology of the environment. Knowledge of the effects of of the environment. Knowledge of the effects of the last Quaternary glaciation, which resulted in the deposition of erodable clays are important in determining the location of shores sensitive to res-ervoir erosion. In addition to physical geography, there also aspects associated with human geogra-phy which are often overlooked in environmental studies of reservoirs. Aspects of human geography include: native groups performing traditional hunt-ing and fishing activities; recreational activity; in-dustry utilizing water as a production resource; use of irrigation water; release of fertilizers and other chemicals by infiltration; discharge of animal and/ chemicals by infiltration; discharge of animal and/ or municipal waste; and river navigation. (Sand-PTT) W91-02396

WAYS OF EVALUATING HUMAN-INDUCED IMPACTS ON THE FUNCTIONING OF WATERBODY ECOSYSTEMS.

Institute of Ecology of the Volga River Basin, Tolyatti (USSR). For primary bibliographic entry see Field 4C. W91-02397

ANNUAL CYCLES OF PLANKTON SPECIES COMPOSITION AND PHYSICAL CHEMICAL CONDITIONS IN SLAPY RESERVOIR DETECTED BY MULTIVARIATE STATISTICS. South Bohemian Biological Centre, Ceske Budejovice (Czechoslovakia). Biomathematical Lab. J. Leps, M. Straskraba, B. Desertova, and L. Prochazkova.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 933-945, 1990. 8 fig, 2 tab, 21 ref.

Descriptors: \*Limnology, \*Phytoplankton, \*Population dynamics, \*Reservoirs, \*Zooplankton, Cluster analysis, Czechoslovakia, Multivariate analysis, Physicochemical properties, Principal component analysis, Seasonal variation, Slapy Reservoir, Species composition.

Data on phytoplankton and zooplankton species composition and abundance as well as physical and chemical conditions from Slapy Reservoir in Czechoslovakia were treated by different methods of multivariate statistics. Three to four consecutive years with rather diversified, extreme hydrological conditions were analyzed. The following methods

were used: classification of samples (dissimilarity: Euclidian distance; hierarchical clustering: Ward's method and average linkage), classification of species and physical-chemical factors (similarity: correlation coefficient; hierarchical clustering: average linkage) and ordination (by principal compo-nent analysis, correspondence analysis and connent analysis, correspondence analysis and con-strained ordinations: redundancy analysis and ca-nonical correspondence analysis). The method of classification of sequences was used for the first time for limnological data. Agglomerative classifi-cation of samples based on standardized data yieldcation of samples based on standardized data yield-ed five distinct groups: winter samples, late winter to spring samples, mainly summer samples, full summer samples and the winter Closterium aspect. Other classifications, although differing, follow the basic seasonal pattern. In the ordination space defined by two principal component axes, three community compositional patterns were distinguished for phytoplankton: the September to April pattern for phytoplankton: the September to April pattern with low biomass of many species, the May peak characterized by the Cryptomonas aspect and the June to August peak with Chlorophyta and bluegreen algae. The summer peak composition was different for the three years observed. In the dry years with strong stratification blue-green algae were highly developed, whereas during the most wet years with reduced stratification a strikingly low phytoplankton biomass was observed. (Author's abstract) thor's abstract) W91-02398

RELATIONSHIP OF RESERVOIR BIOGEO-CHEMICAL PROCESSES TO THE STRUCTUR-AL INTEGRITY OF THE WORLD'S FIRST TO-TALLY ROLLER COMPACTED CONCRETE

Army Engineer District, Portland, OR. Reservoir Regulation and Water Quality Section. For primary bibliographic entry see Field 8F. W91-02399

GROWTH, PRODUCTION, AND DECOMPOSITION DYNAMICS OF SPHAGNUM UNDER NATURAL AND EXPERIMENTALLY ACIDIFIED CONDITIONS.

Alberta Univ., Edmonton. Dept. of Botany. For primary bibliographic entry see Field 5C. W91-02404

PATTERNS AND CONTROLS OF NITROGEN IN TALLGRASS PRAIRIE STREAMS.

Kansas State Univ., Manhattan. Div. of Biology.

Communication BSR-8012166 and BSR-8012166 Ecology ECOLAR, Vol. 71, No. 5, p 2007-2018, October 1990. 6 fig, 3 tab, 55 ref. National Science Foundation grants BSR-8012166 and BSR-8012166 and BSR-8012166 Ecology Ref. Proceedings of the Communication of the Commun

Descriptors: \*Cycling nutrients, \*Kansas, \*Limiting nutrients, \*Nitrogen, \*Prairies, \*Streams, Algae, Nitrates, Phosphates, Riparian vegetation.

A descriptive and experimental approach was used to study patterns of nitrogen concentrations in tallgrass prairie streams in Kansas. Nitrate concentrations varied depending on the year, season, time of day, stream flow conditions, source of water, and location where the sample was taken. Mean and location where the sample was taken, where the initrate concentrations during the dormant season decreased from 1982 to 1984, corresponding to above-normal precipitation during this same period. Nitrate concentrations decreased from hird-order (grass/shrub riparian vegetation) to fourth-order channels (gallery forests). Nitrate, or-ganic N, and total N were higher in a third-order intermittent stream than in a third-order perennial stream. Water from seeps and tributaries had higher nitrate concentrations than stream water; however, streams and tributaries had higher organhowever, streams and tributaries had higher organic N than seeps. Maximum nitrate concentrations during storm flows were directly related to the magnitude of storms and inversely related to the frequency of storm events. The activity of terrestrial vegetation influence nitrate concentrations within streams, seeps, and tributaries; nitrate concentrations were always higher during periods of vegetation dormancy. Aquatic biota influenced both spatial patterns (downstream decrease in ni-

Lakes-Group 2H

trate concentrations and increase in organic N) and diel patterns of nitrate concentration (night > day). Uptake rates of nitrate by biota were greater during the day than during the night as determined by experimental addition of nitrate. Nitrogen and/ or phosphorus limitations of algal growth were tested experimentally using nutrient-diffusing substrata (clay saucers filled with enriched agar) and enrichment of artificial channels. Addition of N and P in combination increased algal biomass (chlorophyll a and ash-free dry mass) over control or single addition of N or P. Thus, algal biomass was N and P limited; however, individual taxa responded to specific N and/or P concentrations or atomic N:P ratio. (Author's abstract)

PREDATION ON AMPHIBIAN EGGS AND TADPOLES BY COMMON PREDATORS IN ACIDIFIED LAKES.
Goeteborg Univ. (Sweden). Dept. of Zoology. For primary bibliographic entry see Field 5C. W91-02407.

SPATIAL ORGANIZATION AND POPULA-TION DENSITY OF THE FISH COMMUNITY OF THE LITTER BANKS WITHIN A CENTRAL AMAZONIAN BLACKWATER STREAM. Central Electricity Generating Board, Fawley (England). Marine Biological Unit. P. A. Henderson, and I. Walker. Journal of Fish Biology JFIBA9, Vol. 37, No. 3, p 401-411, September 1990. 5 fig, 2 tab, 12 ref.

Descriptors: \*Amazon River Basin, \*Aquatic habitats, \*Ecological distribution, \*Fish populations, \*Litter, \*Population density, \*Stream biota, Adaptation, Blackwater streams, Brazil, Evolution, Fish behavior, Population dynamics, Rain forests, Speciation.

Central Amazonian blackwater rivers and streams are known to be poor in minerals and until recently were held to hold a low animal biomass. The Taruma-Mirim is an acidic, blackwater, forest Amazonian stream which flows through igapo forest and enters the Rio Negro close to Manaus, Brazil. The commonly held view that these blackwaters hold an impoverished ichthyofauna is challenged by the results of a study of the fish community of the leaf litter banks in the lower reaches of the Taruma-Mirim. The studied litter banks held about 20 species of fish, all of which were found to live within distinct subregions of the habitat. Average fish density was about 100 individuals/square m. Absolute population sizes were found to be refish density was about 100 individuals/square m. Absolute population sizes were found to be remarkably small; within a 200 square m area the most abundant species had a population size of about 10,000 and the least abundant <100 individuals. High species richness linked to specialized habitat requirements and small population size indicates considerable population stability. Evolution is continually acting on the fish to create spatial niche specialists since the fish to create spatial niche specialists since the fitness of an individual is tied to the ability to find and retain a place within the habitat. Such specialization is only made possible because within the litter a locally generated supply of food is available. The spatial constraints linked to the annual cycle of inundation may have lead to the evolution of such a rich ichthyofauna in central Amazonia. (Mertz-PTT) central Amazonia. (Mertz-PTT) W91-02414

SEWAGE LAGOON TO SPLENDID LAKES. For primary bibliographic entry see Field 5G. W91-02425

SKELETAL DEFORMITIES IN SMALL-MOUTH BASS, MICROPTERUS DOLOMIEUI, FROM SOUTHERN APPALACHIAN RESER-VOIRS.

Georgia Cooperative Fishery and Wildlife Re-search Unit, Athens. For primary bibliographic entry see Field 5C. W91-02440

SHORT TERM RESPONSE TO EUTROPHICA-TION ABATEMENT.

Senter for Industriforskning, Oslo (Norway). For primary bibliographic entry see Field 5G. W91-02447

SEASONAL DELIVERY OF THE PARTICU-LATE FORMS OF PHOSPHORUS TO LAKE GENEVA FROM THE UPPER RHONE RIVER. Geneva Univ. (Switzerland). Inst. F.-A. Forel. D. Burrus, R. L. Thomas, J. Dominik, and J. P.

Aquatic Sciences AQSCEA, Vol. 52, No. 3, p 221-235, 1990. 5 fig, 3 tab, 15 ref.

Descriptors: \*Eutrophication, \*Lake Geneva, \*Nutrients, \*Path of pollutants, \*Phosphorus, \*Rhone River, \*River sediments, \*Seasonal variation, \*Switzerland, \*Water pollution sources, Pollution load, River flow, Sediment discharge, Tur-

Large volume water samples were taken at the mouth of the Upper Rhone River as it enters Lake Geneva (Switzerland). Samples were taken every two weeks from January 1982 until August 1983. Water samples were analyzed for total phosphorus and soluble reactive phosphorus and were centrifuged in the field using a continuous flow centrifuge to recover the suspended solids following sieving at 63 micrometers. The <63 micrometers solids were analyzed for total particulate phosphorus and the suspended solids followed to the suspended solids were analyzed for total particulate phosphorus the suspended solids were analyzed for total particulate phosphorus for the suspender was the suspender were suspended were analyzed for total particulate phosphorus for the suspender was the suspender were suspended were analyzed for total particulate phosphorus for the suspender was the suspender with the suspender was the seving at o3 micrometers. The <03 micrometers solids were analyzed for total particulate phosphorus, organic phosphorus, apatite phosphorus and non-apatite inorganic phosphorus. The >63 micrometer particles were similarly analyzed and the weight of total solids in both size fractions recordnon-apatite inorganic phosphorus. The >63 micrometer particles were similarly analyzed and the weight of total solids in both size fractions recorded. Results were compared throughout the period of record to the hydrograph situated at Porte de Seex. The annual cycle of the Rhone can be divided into a low turbidity, low flow winter period and high flow, high turbidity summer season. Turbidity was well related to discharge. The >63 micrometer sediment was mobilized at 200 cu m/second and thereafter increased in concert with, though at a faster rate than, the <63 micrometer fraction. The coarse fraction contained significant quantities of phosphorus and in 1982 accounted for 26% of the total particulate phosphorus loading. Organic phosphorus and non-apatite inorganic phosphorus were higher in the winter period than in the summer season though apatite phosphorus remained constant throughout the year. Organic phosphorus was believed to be driven primarily from point sources whereas non-apatite inorganic phosphorus, in addition to point sources, had secondary sources in spring and summer due to sheet erosion from the agricultural soils of the valley. Loadings of phosphorus were calculated by four methods which showed internal consistency though they were higher than previous estimates. Bioavailable phosphorus was estimated to account for some 20% of the total phosphorus loading of some 1500 tons, bioavailable phosphorus and was that portion of the phosphorus load believed to be available to generate phytoplankton growth. (Author's abstract)

PHYSICAL, CHEMICAL AND HYDROGRAPHIC INVESTIGATIONS OF AN UPLAND STREAM: A CONTRIBUTION ON THE STANDARDIZATION OF SMALL WATER-COURSES (PHYSIKALISCHE, CHEMISCHE UND HYDROGRAPHISCHE UNTERSUCHUND OND HYDROGRAPHISCHE UNIERSUCHUN-GEN EINESC MITTELGEBIRGSBACHES: EIN BEITRAG ZUR TYPISIERUNG KLEINER FLIESSGEWASSER).

Konstanz Univ. (Germany, F.R.). Limnological

For primary bibliographic entry see Field 2E. W91-02449

VERTICAL MIXING IN UBERLINGER SEE, WESTERN PART OF LAKE CONSTANCE. Heidelberg Univ. (Germany, F.R.). Inst. fuer Um-weltphysik.

G. Heinz, J. Ilmberger, and M. Schimmele. Aquatic Sciences AQSCEA, Vol. 52, No. 3, p 256-268, 1990. 6 fig, 3 tab, 25 ref.

Descriptors: \*Eddy diffusion, \*Germany, \*Lake Constance, \*Lake morphometry, \*Limnology, \*Water circulation, \*Water temperature, Diffusion coefficient, Fluctuations, Lake circulation, Lakes, Phosphorus, Seasonal variation.

Depth variable vertical eddy diffusion coefficients Depth variable vertical eddy diffusion coefficients for heat were calculated from continuously measured temperature profiles in Uberlinger See (western part of Lake Constance, Germany). The temperatures were averaged over vertical intervals of 10 m yielding 14 discrete values (maximum depth of Uberlinger See: 147 m). A linear fit from June 10 to September 29, 1987 was used to smooth the 10 to September 29, 1987 was used to smooth the significant temperature fluctuations caused by internal seiches of Lake Constance. Assuming horizontal homogeneity for the smoother data, the Gradient-Flux-Method was applied to compute vertical diffusion coefficients for heat at different depths using the depth variable volumes and surfaces of the 14 layers. The resulting mean diffusion coefficients for the period from June to September were 0.04 sq cm/sec near the thermocline and up to 0.8 sq cm/sec in deeper strata (accuracy: +/-50%). It was shown that horizontal mixing between Ulerlinger Sec and Obersec (main lake) 50%). It was shown that horizontal mixing between Uberlinger See and Obersee (main lake) altered the computation of vertical diffusion coefficient by less than 50%. A relationship between vertical diffusion coefficients and stability frequency was found that corresponded well to the theory of internal wave induced turbulence. Combining the diffusion coefficients with measured phosphorus profiles, a phosphorus flux from the hypolimnion to the epilimnion of mg P/sq m/day was calculated, corresponding to about 20% of the average external loading per area of Lake Constance in 1986. (Author's abstract) W91-02450

PLANKTONEUSTONIC ALGAE IN THE SUR-FACE FILMS OF LAKE ZURICH: OCCUR-RENCE AND DEPENDENCE ON PHYTO-PLANKTON SUCCESSION.

Zurich Univ., Kilchberg (Swizerland). Hydrobiological-Limnological Station.

A. Nageli, and F. Schanz.

Aquatic Sciences AQSCEA, Vol. 52, No. 3, p 269-286, 1990. 6 fig, 1 tab, 48 ref.

Descriptors: \*Lake Zurich, \*Limnology, \*Phytoplankton, \*Succession, \*Switzerland, \*Taxonomy, Algae, Aquatic populations, Lakes, Neuston, Population density, Species composition.

Samples of surface films and of the underlying bulk water at 0.2 m depth were taken in Lake Zurich (Switzerland) on 48 occasions in 1986, 1988 and 1989, with the aim of assessing the appropriate 1989, with the aim of assessing the appropriateness of applying existing neuston nomenclature to the organisms found in these films, of determining which organisms accumulate there during which periods of time, and of assessing the importance of the phytoplankton community in the development of neustonic biocoenoses. Lake Zurich surface films were found to support a community of high population density, consisting of organisms which had migrated from the benthal or pelagial, or which had entered the film via the atmosphere or inflowing rivers. In all samples, species originating from within the phytoplankton community acfrom within the phytoplankton community ac-counted for the greatest proportion of the total abundance. Several of these species were found to exhibit a special preference for the surface biotope, for example, those with a relative frequency ex-ceeding 10%, a mean enrichment factor exceeding 100, and in the majority of cases, with a greater concentration of individuals in the surface film than in the underlying bulk water layer. Those organisms occurring in the surface films of large water bodies exhibiting these criteria should be considered planktoneustron, whereas the occur-rence of other species in surface films should be considered planktoneustron, whereas the occur-rence of other species in surface films should be considered merely coincidental. The fact that planktoneustonic algae are dominant in the surface films of Lake Zurich means that changes in the species composition of the planktonic algal bio-coenosis directly affect the species composition of the neustonic algal biocoenosis. Thus, just as in the underlying bulk water, a succession can be ob-served in the algal biocoenosis of the surface films. However, because of the higher abundance of

### Field 2-WATER CYCLE

### Group 2H-Lakes

planktoneustonic algae there, this succession is displanktoneustonic ague there, this succession is un-tinct from that occurring in the pelagial. Factors bringing about these differences which are appro-priate for dominant planktoneustonic algae are: alterations in specific gravity; positive phototaxis; and enhancement of growth rates in surface films as compared with the underlying bulk water. (Mertz-PTT)

EXPERIMENTAL COMPARISON OF THE EF-FECTS OF BENTHIVOROUS FISH AND PLANKTIVOROUS FISH ON PLANKTON COMMUNITY STRUCTURE.

COMMUNITY STRUCTURE.
Oklahoma Univ., Norman. Dept. of Zoology.
J. Qin, and S. T. Threlkeld.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119,
No. 2, p 121-141, 1990. 6 fig, 5 tab, 26 ref. NSF
grant DEB 8506112.

Descriptors: \*Experimental design, \*Fish behavior, \*Fish diets, \*Fish populations, \*Lake fisheries, \*Limnology, Algal growth, Benthos, Carp, Ecological effects, Fish, Lake sediments, Lakes, Oklahoma, Phytoplankton, Plankton, Population dynamics, Silverside.

Three experiments of factorial design were conducted to evaluate how benthivorous fish, carp (Cyprinus carpio) and planktivorous fish, silverside (Menidia beryllina) alter plankton community structure. Experiment 1 involved two benthivorous fish treatments (Cyprinus and no fish), three treatments affecting resuspension of sediments (mixing by paddle, use of screens to limit fish access to sediments, and no mixing), and two sediment treatments (present and absent) in water from two lakes (Lakes Broken Bow and Texoma, Oklatwo lakes (Lakes Broken Bow and Texoma, Okla-homa) in a cross-classified experimental design. Experiment 2 included either addition or no addi-tion of planktivorous fish (Menidia), nitrogen or phosphorus in a cross-classified design. Experiment 3 examined the combined effects of planktivorous fish and benthivorous fish on planktivo. Treatments included presence or absence of Cyprinus, Menidia and sediment and nutrient treatments using vestand sediment and nutrient treatments using pres-ence or absence of dead fish, in a cross-classified ence or absence of dead fish, in a cross-classified experimental design. In Experiments I and 3, benthivorous fish enhanced algal fluorescence, seston particles and algal filament abundance. The enhancement of phytoplankton by benthivorous fish occurred whether or not sediment was present and, when sediment was present, whether or not fish had access to the sediment. These results sugrish nad access to the sediment. I nest results sug-gest that benthivorous fish do not affect phyto-plankton solely by releasing sediment-bound nutri-ents. Planktivorous fish enhanced phytoplankton and suppressed large herbivorous zooplankton in experiment 2, but in experiment 3, planktivorous fish did not enhance phytoplankton although crusfish did not enhance phytoplankton although crustacean zooplankton were suppressed. The lack of effect of planktivorous fish on phytoplankton was not altered by the addition of nutrients. In experiment 3, neither benthivorous nor zooplanktivorous fish affected how the other fish affected phytoplankton when they were stocked alone. (Mertz-PTT)
W91-02452

FOODWEB RESPONSE TO THE EXPERIMEN-TAL MANIPULATION OF A BENTHIVORE (CYPRINUS CARPIO), ZOOPLANKTIVORE (MENIDIA BERYLLINA) AND BENTHIC IN-

Oklahoma Univ., Kingston. Biological Station. W. B. Richardson, S. A. Wickham, and S. T.

Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 2, p 143-165, 1990. 5 fig, 3 tab, 83 ref. NSF grant BSR 8805681 and DOE contract DE-AC-09-76SR00819.

Descriptors: "Algal growth, "Aquatic insects, "Benthos, "Carp, "Food chains, "Limnology, "Population dynamics, "Zooplankton, Aquatic production, Benthic fauna, Biomass, Ecological effects, Fish behavior, Fish diets, Protozoa, Rotifers, Secondary productivity.

Key components of benthic and water column foodwebs were manipulated in 18 large outdoor

tanks to test the hypothesis that these foodwebs are strongly coupled. Using a replicated, cross-classi-fied design the presence and absence of (1) a benthivore (common carp: Cyprinus carpio), (2) particulate feeding zooplanktivore silversideL: (Menidia beryllina), and (3) insect benthos were controlled. Fish were the primary determinants of foodweb structure. Both fish strongly enhanced algal biomass (in situ algal fluorescence), but only Cyprinus enhanced algal production. Both fish suppressed large zooplankton, while Menidia also suppressed small individuals. Rotifers and protozoa were enhanced in the presence of both fish. This suggests phytoplankton were responding primarily to fish biomass, not suppression of algal grazers. Cyprinus enhanced bacterial secondary production, while bacterial biomass was enhanced by Cyprinus only in the presence of Mendia. Only Cyprinus significantly suppressed densities of benthic invertebrates. Benthic insects had few direct effects on the water column foodweb. Large numbers of signifiberyllina), and (3) insect benthos were controlled. water column foodweb. Large numbers of signifi-cant 2-way interactions suggest that treatment ef-fects were rarely additive. This result precluded predictions of the effects of combinations of the two fish species based on single species experiments. There was little indication of strong coupling between benthic and water column foodwebs. Only through the feeding activity of Cy-prinus were benthic resources translated into water column biomass. (Author's abstract) W91-02453

FIELD STUDY OF THE EFFECTS OF WATER TEMPERATURE, DISCHARGE AND TROUT ODOUR ON THE DRIFT OF STREAM INVER-

Toronto Univ. (Ontario). Div. of Life Sciences. D. D. Williams.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 2, p 167-181, 1990. 2 fig, 5 tab, 33 ref.

Descriptors: \*Fish behavior, \*Invertebrates, \*Stream biota, \*Stream discharge, \*Temperature effects, \*Water temperature, Amphipods, Beetles, Caddisflies, Chironomids, Copepods, Dipterans, Ecological effects, Fish, Mayflies, Oligochaetes, Ostracods, Stoneflies, Streams.

A manipulative field study was conducted on a uniform riffle on the east branch of Duffin Creek, Durham County, Ontario, Canada, in September, 1981 to examine the effects of three important environmental factors on a variety of drifting in-vertebrate taxa. Factors chosen included water temperature, discharge, and presence of predatory fishes. Day/night differences and catch-net variainsnes. Day/ingint differences and cater-net varia-tion were also examined. Drift response varied according to the scale of changes in water temper-ature and discharge and also among taxa in the hardwater stream. During the period of wide-rang-ing discharge and water temperature, overall night-time drift density was positively related to night-time urit density was positively leated to both discharge and minimum temperature, whereas during more constant conditions it was related to discharge alone. Analysis of catches of individual replicated drift nets showed considerable variance. replicated drift nets snowed considerated variance.

No taxon showed a significant relationship with temperature or discharge during the day but some did at night. Chironomids and mayfiles were associated with minimum night-time temperature only, while caddisflies, beetles and ostracods were assowhite caddishies, decites and obstactous were asso-ciated with discharge; stoneflies and mites were associated with both factors; amphipods, oligo-chaetes, copepods and non-chironomid dipterans were not associated with either factor. During the day, the overall density of drifting animals was greater in the presence of trout odor although density of some taxa was the same in both fish and fishless sections of the stream. At night, only three taxa drifted significantly more in the presence of trout. Mayflies, stoneflies and caddisflies drifting at night were larger in the presence of trout but amphipods were smaller. (Mertz-PTT) W91-02454

EFFECT OF WATER QUALITY ON BACTER-IOPLANKTON DENSITIES IN RIVER, BROOK AND PEAT MINING WATER IN THE BASIN OF THE HUMIC RIVER KIIMINKIJOKI, NORTHERN FINLAND.
Water and Environment District of Oulu (Finland). For primary bibliographic entry see Field 5C. W91-02455

EFFECT OF URANIUM MINE TAILINGS ON RADIONUCLIDE CONCENTRATIONS IN LANGLEY BAY, SASKATCHEWAN, CANADA. Environmental Protection Service, Regina (Sas-For primary bibliographic entry see Field 5B. W91-02460

POLYCHLORINATED BIPHENYL CON-GENERS IN SEDIMENTS, PLANKTON, MOL-LUSCS, CRUSTACEANS, AND EEL IN A FRESHWATER LAKE IMPLICATIONS OF USING REFERENCE CHEMICALS AND INDI-CATOR ORGANISMS IN BIOACCUMULA-TION STUDIES.

Amsterdam City Environmental Health Research Lab. (Netherlands). For primary bibliographic entry see Field 5B. W91-02465

IDENTIFICATION AND INVENTORY PHILIPPINE FORESTED-WETLAND

Philippines Dept. of Environment and Natural Resources, College. Coastal Zone and Freshwater Ecosystems Research Div.

S. R. Baconguis, D. M. Cabahug, and S. N. Alonzo-Pasicolan.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 21-44, June 1990. 4 tab, 56 ref.

Descriptors: \*Aquaculture, \*Ecological effects, \*Forest ecosystems, \*Forest management, \*Forestry, \*Land management, \*Literature review, \*Mangrove swamps, \*Philippines, \*Wetlands, Classification, Forest watersheds, Silviculture, Water resource management, Wetland forests.

The Philippine Archipelago, which comprises more than 7100 islands, has an approximate area of 1,083,000 ha of wetlands. Although the wetland types have been classified as mangroves, swamps, estuaries and deltas, freshwater marsh, aquaculture ponds, rivers, lakes, and man-made resevoirs, this casuaries and dettas, freshwater marsh, aquaculture ponds, rivers, lakes, and man-made resevoirs, this coastal region is predominantly a mangrove ecosystem. In 1918, the mangrove forest was approximately 400,000 ha; by 1978, the area was reduced to 146,140 ha, with only 100,564 ha remaining in 1987. This rapid loss has been caused mainly by timber extraction and aquaculture development. Currently, about 95% of the aquaculture industry, supporting about 2,000,000 people, is done in ponds which were once mangroves, causing the loss of another 3500 ha every year. In an attempt to rectify this alarming situation, both government and private agencies have conducted extensive inventories to determine the exact area of remaining mangroves. The rehabilitation of those areas which were destroyed as a result of repeated overuse and previous mismanagement is the specific focus of future government policies. (D'Agostino-PTT) W91-02473

MANGROVE FOREST RESOURCES IN INDO-

Louisiana State Univ., Baton Rouge. School of Forestry, Wildlife and Fisheries. E. T. Choong, R. S. Wirakusumah, and S. S.

Achmadi. Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 45-57, June 1990. 2 fig, 1 tab, 34

Descriptors: "Ecological effects, "Forest management, "Forestry, "Indonesia, "Mangrove swamps, "Wetland forests, "Wetlands, Agriculture, Aquaculture, Regulations, Resources management

Mangroves are highly specialized and complex ecosystems which form a transitional link between terrestrial and aquatic biota. In Indonesia, mangroves occupy approximately 4.25 million ha, representing almost 20% of the world's mangrove

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forests. Of this, 2.94 million ha are stretched along the coast line of Irian Jaya and are still relatively virgin and unexploited. However, the remaining 1.31 million ha are located in the more populated areas, such as Java, Sumatra, and Kalimantan, where these habitats have been extensively exploitwhere these habitats have been extensively exploited. The primary human disturbances include residential settlement, agricultural land use, aquaculture development, and the for-profit activities of forestry (and fisheries. Limiting the exploitation of the mangroves based on conservation principles has been attempted. Some forest companies have used a management scheme which divides the mangrove forest into sub-blocks of 120 ha, and permits only 4 ha/yr to be cut from each sub-block to insure a 30-year rotation. The government, through the Ministry of Fisheries and the Ministry of Forestry, has adopted a general policy for the of Forestry, has adopted a general policy for the protection, conservation, and wise use of the mangrove resources. It imposes limitations on cutting and preservation of mangrove forests. A 'green belt' 100-400 m wide must be retained along the coast in order to preserve the ecosystem and to insure natural regeneration. A number of man-grove reserves in coastal areas and natural conser-vation areas have been established. Other governwatton areas have been established. Other government agencies and research institutions are studying the ecosystem in an effort to preserve the mangroves for perpetual human use. (D'Agostino-PTT)
W91-02474

MANGROVES IN KAMPUCHEA.

Humboldt State Univ., Arcata, CA. Dept. of Forest Economics. M. S. Sin.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 59-62, June 1990. 4 ref.

Descriptors: \*Forest management, \*Forestry, \*Kampuchea, \*Land use, \*Mangrove swamps, \*Wetland forests, Agriculture, Aquaculture, Resource management, Water resources management.

The total area of mangroves in Kampuchea is estimated at 37,000 ha. However, the forest area of primary importance is located north of Koh Kong within a rectangular area of only 8 x 20 km. This is within a rectangular area of only 8 x Dx Mr. Inti is a multi-use resource, consisting mainly of Rhizophora conjugata, R. mucronata, Avecennia, Bruguiera, and Ceriops. Large quantities of mangrove are used in the production of firewood and charcoal, tannin, and nipa for domestic use. Little is known about how much the mangrove forest afknown about how much the mangrove forest affects the production of fish. However, the practice of active aquaculture is insignificant at present. In some areas where mangrove forests have been reclaimed for agricultural use, coconut, pineapple, rice, and black pepper have been planted. Although there is no apparent population pressure on the mangrove forest, some areas have already been reduced to low shoules of no value. It is more activated to low shoules of no value. reduced to low shrubs of no value. It is suggested that future development of well-formulated management plans will ensure both optimal use of land already cleared, as well as reforestation of areas declines have occurred. (D'Agostino-PTT)

INVENTORY AND MONITORING OF FOR-ESTED-WETLAND RESOURCES OF ASEAN. Pertanian Malaysia Univ., Serdang. Faculty of

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 63-79, June 1990. 2 fig. 2 tab. 24

Descriptors: \*Forest management, \*Land management, \*Network design, \*Resources management, \*Surveys, \*Wetland forests, \*Wetlands, Brunei, Data acquisition, Ecological effects, Estuaries, Forest ecosystems, Indonesia, Malaysia, Monitoring, Philippines, Singapore, Thailand, Water quality, Water resources management, Wetland restoration.

Forested wetlands are highly productive ecosystems which not only provide valuable forest products, but also contribute to estuarine water quality, and play a crucial role in the life-cycles of commercially important aquatic species. In this regard,

there is an urgent need for the proper classifica-tion, management, and utilization of these lands to tion, management, and utilization of these lands to maximize their productivity in response to the growing demands of the increasing population in the ASEAN region (Brunei, Indonesia, Malaysia, The Philippines, Singapore, and Thailand). The authors suggest that an initial step toward this goal is an extensive inventory of the forested-wetland resources, organized and reported from a regional perspective. Furthermore, the causes of degradation of forested areas should also be identified and remitted it is also expensed the entitled and nonitored. It is also proposed that a network should be established to create and maintain a multi-level information structure for the monitor-ing of ASEAN forested-wetland resources for ining of ASEAN forested-wetland resources for in-formation exchange and future planning. Careful inventory and monitoring of these resources will, it is hoped, provide reliable and relevant information for a future long-term management of the wetland forests in the ASEAN region. (D'Agostino-PTT) W91-02476

STATUS AND DISTRIBUTION OF FORESTED WETLANDS IN TROPICAL SOUTH AMERICA. Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.).
H. Klinge, W. J. Junk, and C. J. Revilla. Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 81-101, June 1990. 1 fig, 5 tab, 130

Descriptors: \*Ecological effects, \*Forest ecosystems, \*Forest management, \*Forest ecosystems, \*Forest management, \*Forest watersheds, \*Land use, \*Soil-water-plant relationships, \*South America, \*Wetland forests, \*Wetlands, Brazil, Forestry, Agriculture, Guyana, Hydroelectric plants, Paraguay, Reforestation, Tropical regions, Wetland restoration.

Physiographically, tropical South America is characterized primarily by large watersheds (Amazon, Orinoco, Magdalena, Parana-Paraguay, Sao Fran-Orinoco, Magdaiena, Parana-Paraguay, Sao Fran-cisco), a very long coastland, and uplands (Andean Cordillera, the highlands of Guayana, and central Brazil). Poor drainage, sheet-flooding, fluctuating water levels, and flood pulses contribute to the maintenance of wetlands, mostly forested, which cover approximately 20% of this region's total cover approximately 20% of this region's total area. This literature review data discusses which classifies these tropical forests into four types: tidal, seasonal, aseasonal, and permanent. Their geographical delineation, extent, floristics, and structure are also documented. As observed in other wetland areas, agriculture, animal husbandry, and timber production, as well as hydroelectric power projects, exploit these sites and are the main causes of their destruction. It is concluded that future studies addressing manning, ecological intercauses or tneir destruction. It is concluded that future studies addressing mapping, ecological interplay, seedling establishment, and forest regeneration should be carried out to obtain a more complete knowledge of the composition of these wetlands. (D'Agostino-PTT) W91-02477

VENEZUELAN FLOODPLAIN STUDY ON

THE ORINOCO RIVER.
Fundacion La Salle de Ciencias Naturales, San Felix (Venezuela). Estacion Hidrobiologica de Guayana. G. Colonnello.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 103-124, June 1990. 12 fig, 2 tab, 25 ref. CONICIT (The National Council of Scienand Technological Investigations) Grant S1-

Descriptors: \*Flood plain forests, \*Flood plains, \*Forest ecosystems, \*Orinoco River, \*Soil-waterplant relationships, \*Venezuela, \*Wetland forests, Ecology, Ecosystems, Geomorphology, Species diversity, Topography, Vegetation.

To date, most studies concerning floodplain ecology have been conducted in the Amazon basin. Information about the Orinoco flood plain in Venezuela is currently lacking. With the use of transact surveys, aerial photographs, and horizontal profile elaboration, the floodplain origins, principal geomorphological formations and floristic composition of Laguna de Mamo in eastern Venezuela can be described. The forest has been physiognomically

characterized by three strata: species typical of the lower stratum (Simira rubescens and Caesaria), of the intermediate stratum (Symmeria paniculata and Petrocarpus), and of the upper strata (Piranhea trifoliata and Lonchocarpus). Ten species of climbing vines and 34 tree species have been recorded on a 0.2-ha sample plot. The observed difference in floristic diversity between the depression areas and levees was attributed to differences in inundation and soil types. Together, the topographical and geomorphological make-up of this area will continue to maintain the present physico-biotic characteristics of the existing floodplain complex. (D'Agostino-PTT) w91-02478

WETLAND AND UPLAND FOREST ECOSYS-TEMS IN PERUVIAN AMAZONIA: PLANT SPECIES DIVERSITY IN THE LIGHT OF SOME GEOLOGICAL AND BOTANICAL EVI-

Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Lima (Peru). Mis-sion ORSTOM au Perou.

J. F. Dumont, S. Lamotte, and F. Kahn

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 125-139, June 1990. 4 fig, 85 ref. Supported by ORSTOM/IGP PICG Project 279: Terranes in LatinoAmerica.

Descriptors: \*Amazon River Basin, \*Forest eco-systems, \*Soil-water-plant relationships, \*Species diversity, \*Wetland forests, \*Wetlands, Ecosys-tems, Flood plains, Flooding, Surveys, Tectonics,

Western Amazonia is a mosaic of fossil and current floodplains produced by vast lateral river migrations. Forest ecosystems of the Amazon basin are known to reach very high diversity. Floristic inventories show that species richness is clearly higher in upland than in wetland forests. The analysis of differential faulting and folding tectonic effects on the two western Amazonian morphostructural units clearly indicates that area affected by fluvial dynamics are rather limited within well-defined depressions, the tendency of which is subsidence or entrenchment. Most upland forests have not been affected by fluvial dynamics since the Pleistocene: plant species diversity is highest in these 'terra firme' forests which cover vast areas. While it is argued that the reduced diversity in the wetlands could be due to flooding consequences, it is mainly concluded that the richness of species in the upland forests is the result of their constant favorable ecological conditions. (D'Agostino-PTT) Western Amazonia is a mosaic of fossil and current PTT) W91-02479

GEOGRAPHICAL ASPECTS OF FORESTED WETLANDS IN THE LOWER UCAYALI, PERUVIAN AMAZONIA.

Instituto de Investigaciones de la Amazonia Peruana, Iquitos.

J. L. Parodi, and D. Freitas.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 157-168, June 1990. 1 fig, 2 tab, 21

Descriptors: \*Flooding, \*Forest ecosystems, \*Land use, \*Resources management, \*Ucayali River, \*Vegetation, \*Wetland forests, \*Wetlands, Agriculture, Forest management, Forestry, Land

In Peruvian Amazonia, eleven types of vegetation have been determined in a 2200 square km area of the lower Ucayali River. Of these, ten are forests and one is a floating meadow. Forest ecosystems cover 2133 square km (97%), of which 1335 square km (61%) are wetlands with six forest types, two under the influence of local rainfall and the other four related to the river's flooding pattern. Furthermore, a consistent correlation was observed between flooding patterns, physiographic characteristics and types of vegetation. Although most of the economic activities of the area's fifteen villages are carried out in forested wetlands, little attention are carried out in forested wetlands, little attention has focused on their structure, composition, or fluvial dynamic patterns. Consequently, no regula-

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tions which address optimal multi-land use practices, including agriculture, cattle-raising, wood extraction, agroforestry, fishing, and hunting, have been developed. It is concluded that future studies involving floristics, regeneration, reproductive biology, and water dynamics are necessary to construct a sound management policy for these wetland resources. (D'Agostino-PTT) W91-02481

PALM COMMUNITIES IN WETLAND FOREST ECOSYSTEMS OF PERUVIAN AMA-

ZONIA.

Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Lima (Peru). Mission ORSTOM au Peroru. F. Kahn, and K. Mejia. Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 169-179, June 1990. 6 tab, 21 ref.

Descriptors: \*Flooding, \*Forest ecosystems, \*Palm trees, \*Peru, \*Soil-water-plant relationships, \*Wetland forests, \*Wetlands, Distribution patterns, Ecosystems, Huallaya River Basin, Population density, Species diversity, Ucayali River Basin.

Palms are found in all wetland forests throughout raims are rount in an wetamato toreast intrognout the Amazon basin, with their species distribution being clearly related to flooding patterns and water properties. In this study, surveys of palm communities were carried out in the lower Ucayali and upper Huallaya River valleys, located in the lowland and Andean piedmont regions of Peruvian Amazonia. These ecosystems were characterized by species association, density, and vertical distri-bution of their palm communities. Palms may form almost monospecific stands (e.g. Mauritia flexuosa swamps) or multispecific communities (e.g. season-al swamp forests in the upland valleys or the periodically flooded alluvial soils). In forests floodperiodically flooded alluvial soils). In forests flooded by blackwater streams, palm diversity is low. However, palm density is often high with a characterstic patchy distribution pattern due to clustered species. Together these data delineate the distinct characteristics of each palm community, information which is potentially useful for a more complete definition and identification of the wetland forests in Peruvian Amazonia. (D'Agostino-PTT) W91-02482

STATUS AND TRENDS OF U.S. WETLANDS

AND DEEPWATER HABITATS.
National Wetlands Inventory, Washington, DC.
For primary bibliographic entry see Field 4C.
W91-02483

FORESTED-WETLAND TRENDS IN THE UNITED STATES: AN ECONOMIC PERSPEC-

Southern Forest Experiment Station, New Orleans, LA. C. A. Hickman.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 227-238, June 1990. 2 fig, 22 ref.

Descriptors: \*Forest ecosystems, \*Land management, \*Management planning, \*Resources management, \*Wetland forests, \*Wetlands, Land use, Policy making, Resources development.

Forested wetlands are an invaluable ecological re-Forested wettands are an invaluable ecological re-source which provide wildlife habitats, outdoor recreation, and forestry products, and affect both flood control and water quality. Despite such ben-efits, wetland areas in the United States have decreased dramatically, with some striking regional losses as high as 40-80%. To a large extent, this is the result of past policies, mainly at the federal level, based on economic decisions which favored wetlands development. Historically, however, both public and private agencies have differed in their assessment of the cost to benefit ratio regard-ing the preservation of such lands versus converting the preservation of such lands versus converting them to other uses. Projected trends, such as decreased availability of wetland areas suitable for agriculture, current protective federal policies, changes in the legal system, and improved evaluation techniques, will ensure more intelligent management decisions and reduced wetland losses in the future. (D'Agostino-PTT)

W91-02486

CAT ISLAND SWAMP: WINDOW TO A FADING LOUISIANA ECOLOGY. Southern Forest Experiment Station, New Orle-

For primary bibliographic entry see Field 4C. W91-02490

SOUTHWESTERN RIPARIAN PLANT COM-MUNITIES: SITE CHARACTERISTICS, TREE SPECIES DISTRIBUTIONS, AND SIZE-CLASS

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab. R. C. Szaro.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 315-334, June 1990. 4 fig, 3 tab, 51

Descriptors: \*Arizona, \*Distribution patterns, \*Flood plains, \*Forests, \*Geomorphology, \*New Mexico, \*Riparian vegetation, \*Species composi-Mexico, \*Riparian vegetation, \*Species composition, \*Wetland forests, Statistical analysis, Stream-

Although fluvial geomorphic processes determine the characteristics of a stream channel and its adjacent floodplain terraces, their relationships to riparian vegetation patterns are not completely un-derstood. The effects of elevation, stream direction, stream gradient, and valley cross-sectional area on the distribution of riparian tree species and community types were examined at 153 sites in Arizona and New Mexico. Canonical discriminant analysis of physical site characteristics both within and among the 28 classified communities demon-strated that elevation was the most significant strated that elevation was the most significant factor for all community types, all riparian forest community types, and all riparian scrub community types. Both stream gradient and stream direction also correlated significantly, but on a more limited and local level. Valley cross-sectional area had the least association with riparian vegetation of the four variables examined. Tree distribution studies showed that for some species, dominance or codo-minance was also directly related to site characteristics such as elevation and direction of stream flow. On west-flowing streams, for example, Arizona walnut (Juglans major) was codominant with Zona wantut Qujatas inajor) was codomiant win Arizona sycamore (Platanus wrightii), while on east-flowing streams, sycamore was absent while the walnut species dominated the stands. The con-clusion that distinctive geomorphic settings and riparian plant communities characteristically coexist along an elevational gradient agrees with sin findings in eastern Nevada. (D'Agostino-PTT) W91-02491

SAMPLING INTENSITY AND SPECIES RICH-NESS: EFFECTS ON DELINEATING SOUTH-WESTERN RIPARIAN PLANT COMMUNI-

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab. R. C. Szaro, and R. M. King. Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 335-349, June 1990. 9 fig, 1 tab, 19

Descriptors: \*Data acquisition, \*Land management, \*Land use, \*Network design, \*Population density, \*Riparian vegetation, \*Sampling, \*Species composition, \*Wetland forests, Classification, Comparison studies, Streams, Trees.

The classification of plant communities is a particularly useful tool for the comparison of similar ecological areas in the development of land management plans. Although numerous protocols are currently available, it is of prime importance to determine the minimal number of observations nec-essary to adaquately delineate an individual plant population. In addition, riparian communities in the southwestern United States often occur in patches and isolated pockets along stream corri-dors, making classifications of community types highly dependent on sampling design and method-ology. In this study, the relationship between sam-pling intensity and species richness was investigat-

ed at five sites in south-central Arizona, with difed at rive sites in south-central Arizona, with dif-fering species richness. The findings consistently showed that species ranks, tree density, and basal area estimates required a minimum of 10 observa-tions to stabilize the standard error. Using boottions to stabilize the standard error. Using bootstrap subsampling techniques, it was determined that the variability in species density ranks for the most frequent species, stabilized with approximately 10-20 plots. As species richness increased, so did the variability associated with estimating ranks. Studies based on only a few specifically selected Studies based on only a few specifically selected sample plots may not produce reliable and repeatable results. (D'Agostino-PTT) W91-02492

POSSIBLE EFFECTS OF RESIDENTIAL DE-VELOPMENT ON STREAMFLOW, RIPARIAN PLANT COMMUNITIES, AND FISHERIES ON SMALL MOUNTAIN STREAMS IN CENTRAL

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab. For primary bibliographic entry see Field 4C.

UTILITY OF STREAM HABITAT AND BIOTA FOR IDENTIFYING POTENTIAL CONFLICT-ING FOREST LAND USES: MONTANE RIPAR-

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab. For primary bibliographic entry see Field 4C. W91-02494

POTENTIAL FOR ENHANCING RIPARIAN HABITATS IN THE SOUTHWESTERN UNITED STATES WITH WATERSHED PRAC-

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab. For primary bibliographic entry see Field 4A. W91-02495

USE OF GEOMORPHOLOGY IN THE CLASSI-FICATION OF RIPARIAN PLANT ASSOCIA-TIONS IN MOUNTAINOUS LANDSCAPES OF CENTRAL OREGON, U.S.A.

Silviculture Lab., Bend, OR.

B. L. Kovalchik, and L. A. Chitwood.
Forest Ecology and Management FECMDW, Vol.
33/3, No. 1/4, p 405-418, June 1990. 7 fig. 1 tab, 22

Descriptors: \*Classification, \*Forest ecosystems, \*Geomorphology, \*Oregon, \*Riparian vegetation, \*Riparian waters, Ecosystems, Land use, Mountain streams. Resources management. Streams

Due to the unique position of riparian zones between aquatic and terrestrial ecosystems, resource managers have become increasingly interested in their importance, classification, and management. Understanding of riparian zone ecology, however, is complicated by the extreme variation in its geology, climate, terrain, and hydrology, as well as continued human disturbance. As a result, an accurate determination of the vegetation potential of riparian sites in an effort to develop management options is difficult. A classification system has recently been developed in central Oregon which uses geomorphology to supplement traditional flustic classification, to circumvent this problem. The four level system includes physiographic area, watershed, riparian landform, and fluvial surfaceriparian plant association. It is particularly useful on sites where the natural vegetation composition, soils, or water regimes have been altered by natural or human-induced disturbance. It is suggested tween aquatic and terrestrial ecosystems, resource ral or human-induced disturbance. It is suggested that this scheme is not limited to riparian classifications, but may also be applicable to stream classifi-cation, classification of landforms and plant asso-ciations in upland ecosystems, and model develop-ments for water regimes. (D'Agostino-PTT) W91-02496

STREAMSIDE MANAGEMENT UNITS IN THE PACIFIC NORTHWEST.

### Lakes-Group 2H

Forest Service, Portland, OR. Pacific Northwest For primary bibliographic entry see Field 6B. W91-02497

WOODY PLANT SUCCESSION ON EARTH-QUAKE-UPLIFTED COASTAL WETLANDS OF THE COPPER RIVER DELTA, ALASKA. Pacific Northwest Forest and Range Experiment Station, Juneau, AK. Forestry Sciences Lab. J. F. Thilenius.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 439-462, June 1990. 1 fig. 1 tab, 27

Descriptors: "Alaska, "Copper River, "Deltas, "Earthquake flood, "Forest ecosystems, "Plant populations, "Tidal floods, "Wetland forests, "Wetlands, Coastal environment, Earthquakes, Estuaries, Levees, Salinity, Suspended sediments, Tectonics, Vegetation." Tectonics, Vegetation.

The delta formed by the Copper River stretches for more than 75 km along the south central coast-line of the Gulf of Alaska. All major rivers that flow into the delta carry extremely high levels of suspended sediments. Due to an earthquake in 1964, subtidal and intertidal areas became inter-1964, subtidal and intertidal areas became inter-changed, and marshland advanced into the interti-dal zone. Concurrently, vegetation on many new levees began to change from herbland to shrub-land, most probably due to changes in tidal inunda-tion and water salinity. Since the estuarine circula-tion is dominated by freshwater, higher tides merely raised the level of freshwater on the wet-lands. The initial post-earthquake invasion of woody plants was confined to natural levees. However, recently the shrubs have moved sea-weed into new inter-tidal marshland. Furthermore, shrubland, woodland, and forest vegetation analo-gous to that developing on some supertidal levees snrubland, woodland, and forest vegetation analogous to that developing on some supertidal levees is now present on older wetland habitats further inland. Although the uplift has altered locations and growth rates of the various plant species, the characterisitic nature of wetland plant succession has not been changed. (D'Agostino-PTT) W91-02499

GROWTH AND DEVELOPMENT OF BALD-CYPRESS/WATER-TUPELO STANDS UNDER CONTINUOUS VERSUS SEASONAL FLOOD-ING.

Louisiana State Univ., Baton Rouge. School of Forestry, Wildlife and Fisheries. For primary bibliographic entry see Field 2E. W91-02499

COMPARATIVE STUDY OF THE RESPONSE OF TAXODIUM DISTICHUM AND NYSSA AQUATICA SEEDLINGS TO SOIL ANAERO-BIOSIS AND SALINITY.

Louisiana State Univ. Baton Rouge. Lab. for Wet-land Soils and Sediments. For primary bibliographic entry see Field 2E. W91-02500

LONG-TERM TRENDS IN THE BALD-CY-PRESS (TAXODIUM DISTICHUM) RESOURCE IN LOUISIANA (U.S.A).

Louisiana State Univ., Baton Rouge. Center for Wetland Resources.

Wettand Resources.

W. H. Conner, and J. R. Toliver.
Forest Ecology and Management FECMDW, Vol.
33/3, No. 1/4, p 543-557, June 1990. 4 fig, 2 tab, 74
ref. Louisiana Sea Grant Program and McIntireStennis Project LABO1591.

Descriptors: \*Baldcypress trees, \*Ecological effects, \*Forest ecosystems, \*Forestry, \*Louisiana, \*Swamps, \*Wetland forests, \*Wetlands, Hydrology, Long-term planning, Nutria, Plant populations, Reforestation.

The baldcypress has long been a dominant timber species in Louisiana's wetland forests. Early settlers recognized the value of this species, and due to its durability and workability it remained a stable commodity of the lumber industry from the 18th through the early 20th centuries. Early esti-

mates of the area of baldcypress forests range from 0.67 to 3.64 million ha. Baldcypress timber was cut extensively from 1890 to 1925 when the last virgin stands of timber in the state were depleted. In 1934, there were 0.66 million ha of cutover baldcypress forests in Louisiana. However, recent estimates indicate that there are only 0.14 million ha of indicate that there are only 0.14 million ha of baldcypress swamp forest remaining in the state. Regeneration problems have increased in recent years due to human changes in hydrology and natural subsidence, and the introduction of the rodent, nutria, from South America. Furthermore, even though the growing stock in the state continues to increase, larger trees are being harvested and regeneration is insufficient to restock these transfer seventiane in declarations research. stands, resulting in declining total acreage. Methstands, resulting in deciming total acteage. Mean-ods to plant and protect seedlings and to stem alteration of the area's natural hydrologic process-es must be developed to ensure the survival of these wetland forests for the future. (D'Agostino-W91-02501

INVENTORY TECHNOLOGY: 'EBB TIDES', 'FLASH FLOODS', AND 'WHIRLPOOLS'.
Forest Service, Washington, DC. Timber Manage-

ment Staff.

For primary bibliographic entry see Field 7A. W91-02502

PC-BASED ANALYTICAL STEREOPLOTTER FOR WETLAND INVENTORIES: AN EFFI-CIENT AND ECONOMICAL PHOTOGRAM-METRIC INSTRUMENT FOR FIELD OFFICES. Norges Landbrukshoegskole, Aas. Inst. for Geore-sources and Pollution Research.

For primary bibliographic entry see Field 7B. W91-02503

CLASSIFICATION OF MANGROVE FOREST BY USING 1:40,000-SCALE AERIAL PHOTO-GRAPHS.

Pertanian Malaysia Univ., Serdang. Faculty of Forestry. S. Ibrahim, and I. Hashim.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 583-592, June 1990. 7 tab, 12 ref.

Descriptors: \*Aerial photography, \*Classification, \*Mangrove swamps, \*Mapping, \*Species composition, \*Surveys, \*Wetland forests, \*Wetlands, Data acquisition, Forests, Remote sensing, Vegetation, Watershed management.

The species groups of mangrove forest can be delineated, classified, and mapped by using 1:40,000-scale aerial photographs. A peninsular Malayan mangrove forest (from Kemaman to Kuantan) was delineated in two phases: interpretation of black-and-white panchromatic photographs, and field survey. The results indicate that there are three mangrove forest types, namely the Rhizophora, the Avicennia-Sonneratia, and the mixed-mangrove type which can be delineated mixed-mangrove type which can be delineated with 90% correct interpretation. In an area of 2214 with 90% correct interpretation. In an area of 2214 ha, of which 2% is Avicennia-Sonneratia, 24% Rhizophora and 74% mixed-mangrove, Avicennia-Sonneratia has the highest stand density with 13,348 trees ha -1, followed by Rhizophora with 6697 and mixed-mangrove forest with 1997. It is concluded that aerial photography is a useful method for the delineation, classification, and mapping of mangrove forests. (D'Agostino-PTT) W91-02504

USE OF HIGH-ALTITUDE AERIAL PHOTOGRAPHY FOR INVENTORYING FORESTED WETLANDS IN THE UNITED STATES.

Fish and Wildlife Service, Newton Corner, MA. R. W. Tiner. Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 593-604, June 1990. 2 tab, 10 ref.

Descriptors: \*Aerial photography, \*Mapping, \*Wetland forests, \*Wetlands, Classification, Data interpretation, Forests, Infrared imagery, Maps, National wetlands, Surveys, Watershed manage-

Currently, the National Wetlands Inventory Project (NWI) prepares wetland maps using stereoscopic interpretation of high-altitude aerial photographs. This is a multi-step procedure which includes preliminary aerial photography, selection of specific field study sites, stereoscopic interpretation of serial photos, preparation of large-scale wetland maps, coordination of preliminary map review, and subsequent editing for final map production. Leaf-off, color infrared aerial photography from the early spring is the method of choice for detecting deciduous forested wetlands in temperate regions. Wetlands which are difficult to identify on the ground, such as evergreen forested wetlands, flooded deciduous forests, rain forest regions and hydrologically altered forests are the regions and hydrologically altered forests are the most difficult to photo-interpret. In these cases most difficult to photo-interpret. In these cases topographic landscape position studies, subtle photo signatures, more extensive field-work, and collateral information, such as soil surveys, must be included to produce useable maps. It is concluded that high-altitude aerial photography is an efficient and cost-effective means of identifying and classifying wetlands for inventory preparation on a national, regional, and statewide basis. (D'Agostino-PTT) PTT W91-02505

SYNOPTIC INVENTORY OF RIPARIAN ECO-SYSTEMS: THE UTILITY OF LANDSAT THE-MATIC MAPPER DATA.

Environmental Monitoring Systems Lab., Las Vegas, NV. M. J. Hewitt.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 605-620, June 1990. 8 fig, 6 tab, 17

Descriptors: \*Data acquisition, \*Mapping, \*Riparian vegetation, Ecosystems, Washington, Yakima

It has been estimated that almost 66% of the It has been estimated that almost 66% of the naturally occurring riparian vegetation in the United States has been eradicated since 1776. In spite of the critical importance of riparian zones to the maintenance of wildlife populations, no adequate methods currently exist for the synoptic inventory and assessment of this critical resource. This study analyzes the feasibility of utilizing Landsat Thematic Mapper data for the inventory of riparian habitats along the Yakima River of central Washington. Although final map accuracy assessment was determined to be only 80%, it was concluded that an adjustment of the experimental concluded that an adjustment of the experimental concluded that an adjustment of the experimental design could significantly increase map accuracy. The recommended parameters include the employment of both a temporal approach, such as selecting images from different seasons, as well as a buffer algorithm that masks out all pixels greater than n distance from the water class. With these modifications, high-resolution satellite systems are potentially useful in providing synoptic inventory maps of riparian habitats. (D'Agostino-PTT) W91-02506

ECOLOGY OF WATER-FILLED TREEHOLES IN AUSTRALIAN RAINFORESTS: FOOD WEB REASSEMBLY AS A MEASURE OF COMMU-NITY RECOVERY AFTER DISTURBANCE,

University of New England, Armidale (Australia).
Dept. of Ecosystem Management.
B. Jenkins, and R. L. Kitching.

Australian Journal of Ecology AJECDQ, Vol. 15, No. 2, p 199-205, June 1990. 5 fig, 29 ref.

Descriptors: \*Ecology, \*Ecosystems, \*Food chains, \*Rain forests, \*Treeholes, Australia, Phytotelemata, Predation, Species composition, Species diversity, Subtropic zone.

Ten water-filled tree holes which belong to the Ien water-illied tree noies which belong to the groups of lentic, aquatic ecosystems known as phytotelmata, in a subtropical rainforest were emptied out thereby posing a major perturbation on the community of organisms which occupied these habitat units. During the process of food web reassembly following this disturbance, the average number of predator species in the web increased as did the average number of prey species. Predator-

### Field 2—WATER CYCLE

### Group 2H-Lakes

prey ratios increased in magnitude with the number of days after the disturbance. Furthermore, the characteristic mean predator-prey ratio of the original community was gradually restored as the food web reassembled. The number of prey species was found to be a better predictor of the number of predator species during community recovery than vice versa. The increasing number of trophic links in the food web over the period of reassembly, due mainly to the increase in the number of predacious mainty to the increase in the number of predactous species in the web, provided a good overall measure of community recovery. A model of food web reassembly using the relationships among food web statistics can be used to assess the rate of recovery of a community after a disturbance of the food web on a community after a disturbance of the food web at the regional level of resolution. Food web statis-tics may also be useful in developing models for large ecosystems. (Author's abstract) W91-02514

VEGETATION CHANGE ON THE OUSE WASHES WETLAND, ENGLAND, 1972-1988 AND EFFECTS ON THEIR CONSERVATION

Royal Society for the Protection of Birds, Sandy

Royal Sceley for the Vicensia of Sceley for the Congland, N. D. Burgess, C. E. Evans, and G. J. Thomas. Biological Conservation BICOBK, Vol. 53, No. 3, p 173-189, 1990. 5 fig. 4 tab, 22 ref.

Descriptors: \*Conservation, \*Ecology, \*Ecosystems, \*Grasses, \*Grasslands, \*Vegetation, \*Wetlands, England, Flooding, Grazing, Hay, Ouse Washes, Resources management, Species composi-tion, Species diversity, Vegetation effects.

A re-survey of wetland vegetation on the Ouse Washes in 1988 indicated that it has changed drawasties in 1966 indicated that it has changed una matically in 16 years. Glyceria maxima swamp (National Vegetation Classification (NVC) S5) and Agrostis stolonifera-Alopecurus geniculatus inun-dation grassland (NVC S13) have more than doudation grassland (NVC S13) have more than dou-bled their area, whereas Phalaris arundinacea swamp (NVC S28), Holcus lanatus-Deschampsia cepitosa coarse grassland (NVC M69) and Carex riparia swamp (NVC S6) have declined by at least three-quarters of their previous area. Increased flooding, especially in the late spring and early summer, and reduced levels of grazing and hay-making are believed to have caused these changes, with increased flooding probably the single most important factor. The increased incidence of flood-ingerial control of the company of the company of the company to the company of the company important factor. The increased incidence of flood-ing is caused by four factors: (1) upstream channel ing is caused of our factors: (1) upstream channel improvements on the Ouse River and better land drainage; (2) increased siltation of waterways on either side of the Washes which reduces their water channel capacity; (3) increased siltation at the outflow of the Washes which slows water flow the outflow of the Washes which slows water flow out of the system; and (4) possible changes in the operation of a sluice which allows water onto the Washes. The vegetation changes have resulted in a reduction of plant species diversity in grazed, hayed and unmanaged Washes, but especially in the unmanaged Washes. They may have also affected ornithological use of the site but this requires further investigation. (Author's abstract) W91-02515

ASSESSMENT OF BANK SLOPE AS A PRE-DICTOR OF CONSERVATION STATUS IN RIVER CORRIDORS.

RIVER CURRIDORS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
M. A. Learner, D. W. Bowker, and J. Halewood.
Biological Conservation BICOBK, Vol. 54, No. 1, p 1-13, 1990. 4 fig. 5 tab, 12 ref.

Descriptors: \*Conservation, \*Ecology, \*Ecosystems, \*Rivers, \*Stream banks, \*Taxonomy, Bank slope, Fauna, Flora, Population density. River Arrow, River Monow, River We, Species composition, Species diversity, Statistical analysis,

The importance of bank slope as a predictor of conservation status in river corridors was assessed by means of a survey of the taxonomic richness, taxonomic density and relative abundance of aquatic and terrestrial macro-invertebrates, vascular plants and bryophytes in aquatic, marsh, bank and adjacent land habitats at 22 sites on three

rivers (River Wye and two of its tributaries, the Rivers Arrow and Monnow) at bank slopes ranging from 3 to 50 degrees. Bivariate and multivariate analyses demonstrated that bank slope was a poor predictor of conservation status in terms of the evaluation criteria employed. However, the taxonomic richness of the flora was positively correlated with the width and height of the bank. There was some indication that narrow banks with steep slopes supported a greater density of plant taxa than wide banks with shallow slopes. The taxonomic richness of the flora was not correlated with that of the fauna. No correlations were found between the taxonomic richness and density on the bank and those on the adjacent land. (MacKeen-PTT) W91-02516

EFFECTS OF POOL SIZE AND ISOLATION ON AMPHIBIAN COMMUNITIES.
Katholieke Univ. Nijmegen (Netherlands). Dept. of Animal Ecology.
R. Laan, and B. Verboom.

Biological Conservation BICOBK, Vol. 54, No. 3, p 251-262, 1990. 2 fig. 4 tab, 14 ref.

Descriptors: \*Amphibians, \*Aquatic habitats, \*Ecology, \*Ecosystems, \*Species diversity, Fauna, Forests, Habitats, Isolation, Limburg, Pools, Regression analysis, Species composition, The Neth-

An investigation of the presence of amphibians was carried out in 38 old and 39 recently constructed pools in the South of Limburg, The Netherlands. In order to assess possible effects of pool size and isolation on the number of species, characteristics of the pools and the surrounding landscape were analyzed by means of stepwise multiple regression analysis. In all analyses habitat variables concerning the pool were corrected for. Significant effects of pool size were found for old pools only. In both old and new pools species number turned out to be positively influenced by the vicinity of a wood. Woodland is considered here as an element in-Woodland is considered here as an element in-creasing the connectivity of a landscape and as a part of the land habitat of amphibians. Pool age was the best predictor of species number in the new pools. The three most abundant species dis-played differences in colonization rate. These dif-ferences turned out to be related to their abundance. (Author's abstract)

DISTRIBUTION OF CALIFORNIA STREAM FISHES: INFLUENCE OF ENVIRONMENTAL TEMPERATURE AND HYPOXIA. California Univ., Davis. Dept. of Wildlife and Fisheries Biology.

J. J. Cech, S. J. Mitchell, D. T. Castleberry, and M. McErree.

M. McEnroe. Environmental Biology of Fishes EBFID3, Vol. 29, No. 2, p 95-105, October 1990. 1 fig, 4 tab, 35

Descriptors: \*Dissolved oxygen, \*Ecology, \*Environmental effects, \*Fish, \*Fish physiology, \*Stream fisheries, \*Water temperature, California, Fish populations, Habitats, Metabolism, Streams.

Metabolic rates of seven fish species were used to assess the importance of temperature and dissolved oxygen as factors affecting the longitudinal distributions of stream fish within California drainages. Metabolic rates of all species generally increased at higher acclimation temperatures and with abrupt nigher accimation temperatures and with aorupi temperature increases. In response to low dissolved oxygen, four species showed no change in metabolic rates up to a threshold temperature where hypoxia-induced metabolic depression was apparent. These threshold temperatures were near the lethal temperatures for each species. In contrast, two species showed metabolic depressions at every temperature, whereas one showed no depression at any temperature. In general, species occupying similar longitudinal positions in California streams behaved similarly in their metabolic responses. For most species, there was good correspondence bemost species, there was good correspondence be-tween metabolic response and relevant field obser-vations of occurrence. In cases where the analysis of metabolic rates predicted species presence in

waters where they did not exist, other abiotic factors, such as flow rate, or biotic factors, such as predation or competition must be considered. (Author's abstract) W91-02518

COONGIE LAKES CONTROL ZONE--A MAP AND NOTE FOR THE SURFACE GEOLOGY AND TERRAIN.

G. W. Krieg, and R. A. Callen. Mines and Energy Review South Australia, No. 157, p 59-61, 1990. 2 figs, 4 ref.

Descriptors: \*Australia, \*Habitats, \*Lakes, \*Maps, \*Wetlands, Arid lands, Coongie Lakes, Cooper Creek, Innamincka Station Regional Reserve, Surficial geology, Topology.

The Coongie Lakes wetland, fed by Cooper Creek, is an almost permanent, freshwater, shallow lake system extending for over 50 km in South Austrasystem extending for over 30 km in South Austra-lia's arid northeastern desert dunefields. This unique habitat, which supports an abundant aquatic and bird life, and a fringing eucalypt wood is protected under the National Parks and Wildlife Act as part of the Innamincka Station Regional Reserve, while allowing other economically important activities to proceed. An accompanying map, shows the surface geology and terrain, differ-entiates the main landscape units, and was compiled to assist land management of the area. Re-search into the sedimentology and hydrodynamics of the Coongie Lakes system would be warranted if any major surface or subsurface extraction of materials is contemplated. (Author's abstract)

SENSITIVITY ANALYSIS OF NINE DIVERSI-TY AND SEVEN SIMILARITY INDICES.

National Park Service, Fort Collins, CO. Water Resources Div.

T. P. Boyle, G. M. Smillie, J. C. Anderson, and D.

Research Journal of the Water Pollution Control Federation JWPFA5, Vol. 62, No. 6, p 749-762, September/October 1990. 22 fig, 1 tab, 17 ref.

Descriptors: \*Aquatic ecosystems, \*Limnology, \*Monitoring, \*Sensitivity analysis, \*Species diversity, \*Water quality, Ecology, Population density, Simulation analysis, Species composition, Statistical analysis.

Sixteen indices commonly used to assess the status of aquatic communities in water quality studies were evaluated using computer simulation techniques to determine specific index responses. Three communities of different initial structure (19, 38, communities of different initial structure (19, 38, and 83 species) were generated using the lognormal equation. Each community was then perturbed in three ways: common species disproportionally reduced, and rare species disproportionally reduced. The behavior of the indices was analyzed graphically and differential response due to initial community structure and type of community change was documented. The results indicated that the response of the community level indices was dependent on the the community ever indices was dependent on the initial structure of the community and the manner in which the community was perturbed. In general, community level indices at the present stage of technical development may give very misleading biological interpretations of the data they are intending to summarize. Diversity indices, in particu-lar, should not be used except in concert with other indices. Further research is recommended to determine the applicability of the specific indices to different aquatic ecosystems. (MacKeen-PTT) W91-02534

BREEDING BIOLOGY OF THE SPOTTED SALAMANDER AMBYSTOMA MACULATUM (SHAW) IN ACIDIC TEMPORARY PONDS AT CAPE COD, USA.

Cape Cod National Seashore, South Wellfleet,

For primary bibliographic entry see Field 5C.

Lakes-Group 2H

SEDIMENT OXYGEN DEMAND MODEL: METHANE AND AMMONIA OXIDATION. Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program. D. M. Di Toro, P. R. Paquin, K. Subburamu, and

D. A. Gruber.

Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 5, p 945-986, 1990. 13 fig, 5 tab, 50 ref, 2 append.

Descriptors: \*Ammonia, \*Methane, \*Model studies, \*Sediment chemistry, \*Sediment oxygen demand, \*Water pollution control, Chemical analysis, Lake sediments, Mathematical analysis, Mathematical models, Oxidation, Stream sediments.

A model of sediment oxygen demand (SOD) is presented that relates SOD to the extent of oxidation of dissolved methane and ammonia generated in the anaerobic zone of the sediment of lakes and streams. The fluxes of dissolved methane and ammonia from the sediment to the overlying water, as well as methane and nitrogen gas fluxes that escape a bubble are included in the model. The three well as methane and nitrogen gas fluxes that escape as bubbles, are included in the model. The three as bubbles, are included in the model. The three model parameters—the dissolved methane mass transfer coefficients and the two oxidation rate parameters—were estimated from laboratory and field data sets. The effect of overlying water dissolved oxygen and temperature was also examined. The importance of the gas fluxes and their quantitative relationship to SOD was established. Any field program that includes the measurement of SOD should also include the measurement of nitroen and methane fluxes as well. The model is gen and methane fluxes as well. The model is limited to freshwater sediments since the oxidation of sulfides is not included. The contribution from the respiration of benthic macro fauna is also not incorporated. (Author's abstract)

ACCURATE METHOD FOR CALCULATION OF SATURATION DO.

Wuxi Pearl Lustre Pigment Factory (China). For primary bibliographic entry see Field 5G. W91-02577

AQUATIC AND CERTAIN WETLAND VASCU-LAR VEGETATION OF REELFOOT LAKE, 1920S-1980S. III. SUBMERSED MACRO-PHYTES.

PHYTES.
Tennessee Univ. at Martin.
J. W. Henson.
J. W. Henson.
Journal of the Tennessee Academy of Science
JTASAG, Vol. 65, No. 4, p. 107-111, 1990. 1 fig. 1
tab, 23 ref, Tennessee Wildlife Resources Agency
Contracts ID 2282, ID 2539, and ID 2611.

Descriptors: \*Aquatic plants, \*Limnology, \*Macrophytes, \*Reelfoot Lake, \*Submerged aquatic plants, \*Wetlands, Ecosystems, Hornwort, Pondweeds, Seasonal variation, Species composition, Tennessee, Water level, Waterlilies, Waterweeds.

Ceratophyllum demersum L. has been known from Reelfoot Lake since the early 1920s and was the predominant submersed macrophyte from 1933 through the 1950s. In 1983 it was dominant during predominant submersed macrophyte from 1933 through the 1950s. In 1983 it was dominant during the summer and early fall months. Potamogeton crispus L., an exotic, rapidly became spring dominant soon after its introduction in 1959. Life cycle differences reduce competition between these plants. The 1983 distributions of 4 other less-prevalent species, P. pectinatus L., P. pusillus L., Elodea nuttallii St John, and Cabomba carloiniana Gray, appeared to be similar to those of the early 1940s but abundances likely had been reduced. Fluctuations of all had occurred over the years. Rare species in 1983, previously occurring in quantity were: P. nodosus Poir., Najas guadalupensis Magnus, Heteranthera dubia MaxM., Ranunculus Mashallaris Raf., and Zannichellia palustris L. At least since 1983, Utricularia billora Lam. has persisted in numerous shallow pools as sparse plants least since 1983, Utricularia biflora Lam. has per-sisted in numerous shallow pools as sparse plants within other dense vegetation. Elevated mean lake levels during the last four decades, and species competition, are considered primary factors con-tributing to the reduction of less dominant species. Fluctuations of submersed species have occurred since the White Amur (Ctenopharyngodon idella Val.) was released into the lake during the winter of 1983-84. (See also W91-02582) (Author's ab-stract)

W91-02581

AQUATIC AND CERTAIN WETLAND VASCU-LAR VEGETATION OF REELFOOT LAKE, 1920S-1980S. IV. SEASONALLY EMERGENT MACROPHYTES.

MACROPHY1ES.
Tennessee Univ. at Martin.
J. W. Henson.
Journal of the Tennessee Academy of Science
JTASAG, Vol. 65, No. 4, p 112-116, 1990. 2 tab,
27 ref. Tennessee Wildlife Resources Agency Contracts ID 2282, ID 2539, and ID 2611

Descriptors: \*Aquatic plants, \*Emergent aquatic plants, \*Macrophytes, \*Reelfoot Lake, \*Water pollution effects, \*Wetlands, Herbicides, Limnology, Marshes, Pesticides, Primrose, Seasonal variation, Smartweed, Species composition, Species diversity, Swamps, Tennessee, Water level, Waterli-

Seasonally emergent macrophytes of Reelfoot Lake were surveyed from 1983-88. These nonper-Seasonally emergent macrophytes of Reelfoot Lake were surveyed from 1983-88. These nonpersistent marshes are compared and contrasted with those reported for earlier periods. Since about 1943, the foremost abiotic influence upon vegetational change is believed to have been higher, average water depths. Previous herbicide applications are thought to have exerted minimal effects upon the status of nonpersistent marshes of the 1980s. Two anchored species have been continually dominant: Nelumbo lutea Pers. and Nuphar luteum subsp. macrophyllum Beal. Relatively pure strands of both were more extensive 30-60 years ago. Nymphaea dodata Ait, has increased since the 1930s, likely because of reduced competition from the dominant anchored species. Concurrently, the earlier shallow-water habitat of Brasenia schreberi Gmel. has been essentially eliminated by thick stands of both seasonally emergent and submersed species. The following three species have spread into the expanding swampy areas over the past 40 years: Polygonum densiforum Meisn., Ludwigia peploides (HBK) Raven and Limnobium spongia (Bosc.) Steud. In shallow water, nonpersistent marshes, P. densiflorum promotes the slow succession to tree swamps. The small floating macrophytes (Duckweeds, Lemna minor L. and Spirodela polyrhiza (L.) Schleid; Watermeals, Wolffia spp.; and Mosquito Fern, Azolla caroliniana L) have been abundant and widespread within nondela polyrhiza (L.) Schleid; Watermeals, Wolffia spp.; and Mosquito Fern, Azolla caroliniana L.) have been abundant and widespread within non-persistent marshes and swamps for many years. Justicia americana (L.) Vahl and Hydrocotyle ranunculoides L. f., recent introductions and still localized on the lake, have the potential for spreading into other lake selections. (See also W91-02581) (Author's abstract) (Author's abstract) W91-02582

RESPONSE OF THE MICROBIAL LOOP TO PHYTOPLANKTON SPRING BLOOM IN A LARGE PREALPINE LAKE. Konstanz Univ. (Germany, F.R.). Limnological

Inst. T. Weisse, H. Muller, R. M. Pinto-Coelho, A. Schweizer, and D. Springmann.
Limnology and Oceanography LIOCAH, Vol. 35, No. 4, p 781-794, June 1990. 6 fig. 3 tab, 62 ref. Deutsche Forschungsgemeinschaft Grant L/63 699, and Brazilian Ministry of Education Grant CAPES PROC 386/862

Descriptors: \*Algal blooms, \*Limnology, \*Mountain lakes, \*Phytoplankton, Bacteria, Biomass, Food chains, Germany, Lake Constance, Microbiological studies, Phosphates, Population dynamics, Primary productivity, Seasonal variation.

Abundance, biomass, production, and grazing loss rates of phytoplankton, free-living bacteria, and Protozoa were assessed during an intense spring phytoplankton bloom in prealpine Lake Constance (Bodensee). More than 50% of the primary production was channeled through the microbial loop. Bacteria and ciliates responded rapidly to increasing phytoplankton biomass and production. Maximal growth rates of bacteria and protozoa were slightly lower than those of the dominating phytoplankton species. Averaged over the spring bloom, bacterial C amounted to 21% of phytoplankton C, and bacterial production to 18% of particulate

primary production. An increase of heterotrophic flagellate populations was prevented by grazing within the microbial loop, probably by the feeding impact of ciliates. Although ciliates controlled flagellate production, they satisfied their own food demand by feeding on algae, and consumed 14% of primary production. Metazoan microzooplankton (copepod nauplli and rotifers) removed 7% of the phytoplankton production. Herbivorous metazooplankton ingested slightly less. Therefore the phytoplankton bloom was not terminated by excess grazing. PO4 depletion and subsequent sedimentation was most likely the prime cause for the termination of the spring bloom. (Author's abstract) W91-02384

PLANKTONIC COMMUNITY STRUCTURE DETERMINES THE FATE OF BACTERIAL PRODUCTION IN A TEMPERATE LAKE.

New York Botanical Garden, Bronx, NY. Inst. of

M. L. Pace, G. P. McManus, and S. E. G. Findlay. Limnology and Oceanography LlOCAH, Vol. 35, No. 4, p 795-805, June 1990. 4 fig, 3 tab, 60 ref. NSF Grant BSR88-05893.

Descriptors: \*Bacteria, \*Limnology, \*Plankton, \*Primary productivity, \*Species composition, Daphnia, Ecosystems, Food chains, Microbiologi-cal studies, New York, Phytoplankton, Rotifers, Seasonal variation, Upton Lake.

An examination was made of the fate of planktonic bacterial production and the balance between bacterial growth and grazing mortality in the surface waters of Upton Lake, New York. Growth rates were measured by the incorporation of (3-H)thymidine into DNA. Grazing rates on bacteria were determined with small cells produced by a mutant strain of E. coli and made either florescent or radioactive to monitor feeding. Bacterial community turnover times calculated from either growth or grazing rates ranged from 1.5 to 16 days. On the basis of these data and the results of 29 other studies, most bacterial communities appear to have turnover times substantially > 1 day. The measurements of feeding rates on bacteria frequently exceeded estimates of growth. Limitations of precision and doubts about the accuracy of methods make attempts to balance measurements tions of precision and doubts about the accuracy of methods make attempts to balance measurements of bacterial growth and grazing with current techniques unrealistic. The fate of bacterial production depends on planktonic community structure. Flagellates were the primary consumers of bacteria in winter and fall. At other times, Daphnia galeata consumed most of the bacterial production. Clinicates and rotifers were never important bacterial grazers. In Upton Lake, large populations of daphnia effectively break the microbial loop and funnel bacterial production to higher consumers. (Author's abstract) W91-02585 W91-02585

TYPE OF SUSPENDED CLAY INFLUENCES LAKE PRODUCTIVITY AND PHYTOPLANK-TON COMMUNITY RESPONSE TO PHOSPHORUS LOADING.

Hampton Univ., VA. Center for Marine and Envi-ronmental Studies.

ronmental studies.

B. E. Cuker, P. T. Gama, and J. M. Burkholder.
Limnology and Oceanography LIOCAH, Vol. 35,
No. 4, p 830-839, June 1990. 8 fig. 1 tab, 23 ref.
EPA Grant R813315-01-0.

Descriptors: "Aquatic productivity, "Clays, "Lim-nology, "Phosphorus, "Phytoplankton, "Suspend-ed sediments, Algae, Biomass, Kaolinite, Lake sediments, Montmorillonite, North Carolina, Pri-mary productivity, Sediment chemistry, Turbidity.

The effects on phytoplankton and limnetics of two The effects on phytoplankton and limnetics of two different types of suspended sediments, and their interactions with P loading, were tested in a small North Carolina piedmont lake. Limnocorrals were used in a complete, triplicated six-treatment, blocked design. Treatments were loaded with P, kaolinitic clay (K), K+P, montronillonitic clay (M) and M+P. M caused more turbidity and stayed in suspension longer than K. Consequently, the light dependent parameters, net community

### Group 2H-Lakes

productivity (NCP), chlorophyll concentration, and algal density were lowest in the M and highest in the P treatment. Combined P and K loading promoted clearing for both sediments and mitigated their effects on algal densities and NCP. Flagellated algae and nonfilamentous cyanophytes dominated the control community. The P treatment had blooms of Anabaena. Without fertilization, both claus resulted in searce flocalitate dominated comolooms of Anaoaena. Witnout retruization, ooin clays resulted in sparse, flagellate-dominated communities. The M+P community, like that of the P treatment, was dominated by Anabaena, but total algal densities were suppressed. In contrast, the K+P community lacked Anabaena and was similar to the control in algal quantity and composition (Authoritection Control of the Control of t tion. (Author's abstract) W91-02586

QUANTITATIVE ASSESSMENT OF THE SOURCES AND GENERAL DYNAMICS OF TRACE METALS IN A SOFT-WATER LAKE. Lancaster Univ. (England). Inst. of Environmental

and Biological Sciences.

For primary bibliographic entry see Field 5B. W91-02587

SULFUR STORAGE AND ALKALINITY GENERATION IN NEW ENGLAND LAKE SEDI-MENTS

Marine Biological Lab., Woods Hole, MA. Eco-

A. E. Giblin, G. E. Likens, D. White, and R. W.

Limnology and Oceanography LIOCAH, Vol. 35, No. 4, p 852-869, June 1990. 9 fig, 2 tab, 71 ref. NSF Grant BSR 86-15191.

Descriptors: \*Acid rain, \*Acid rain effects, \*Alka-linity, \*Lake sediments, \*New England, \*Path of pollutants, \*Sulfur, \*Water pollution sources, Pyrite, Sediment contamination, Sulfates, Sulfides, Water quality.

Measurements of the rates of burial and forms of reduced S in lake sediments were made to evaluate the importance of SO4 reduction to the alkalinity budget of several New England lakes. The contribution of dissimilatory SO4 reduction to alkalinity generation in these lakes was estimated conservatively to range from 1 to 75 meq/sq m/yr. The contribution of both assimilatory and dissimilatory SO4 reduction ranged from 10-159 meq/sq m/yr. For lakes with water residence times on the order of years, SO4 reduction can be important in controlling lake water alkalinity. Substantial quantities of inorganic reduced S were found in sediments of mearly all lakes studied. The majority was present as pyrite. In most lake concentrations of inorganic Measurements of the rates of burial and forms of as pyrite. In most lake concentrations of inorganic as pyrite. In most lake concentrations of inorganic reduced S were higher in sediments deposited in the last 85 yr when compared to older sediments. In contrast, the ratio of C to organic S showed no consistent trend with depth in most lakes. It appears that in these lakes, most of the sulfide produced from SO4 reduction is stored primarily as inorganic forms rather than as C-bonded S. In lakes with highly organic sediments and low Fe concentrations, it was found that a considerable concentrations, it was found that a considerable portion of the sedimentary Fe was present as ferrous sulfides. If these lakes were typical, alkalinity generation by reduced S storage in lakes with organic rich sediments in the northeastern US already may be limited by Fe availability. (Author's abstract) W91-02588

INTEGRATED APPROACH TO QUANTIFY GROUNDWATER TRANSPORT OF PHOS-PHORUS TO NARROW LAKE, ALBERTA.

Alberta Univ., Edmonton. Dept. of Zoology. For primary bibliographic entry see Field 2F. W91-02589

GROUNDWATER RECHARGE FROM LAKE

Indiana Univ.-Purdue Univ. at Fort Wayne. Dept. of Earth and Space Sciences.
For primary bibliographic entry see Field 2F.
W91-02591

RE-EXAMINATION OF SEICHE PERIODS OF LAKE VATTERN,

Goeteborg Univ. (Sweden). Dept. of Oceanogra-

phy. G. G. A. Bjork, and P. A. Lundberg. Tellus TELLAL, Vol. 42A, No. 5, p 615-626, 1990. 7 fig, 2 tab, 17 ref. Swedish Natural Science Research Council Contract NFR G-4768.

Descriptors: \*Lake Vattern, \*Limnology, \*Seiches, \*Sweden, Lake morphology, Mathemati-cal equations, Mathematical studies, Sensitivity analysis, Topography, Water level.

A newly developed perturbation technique for re-solving Chrystal's classical seiche problem has been applied to Vattern, a deep and elongated lake in central Sweden. Theoretical predictions of the standing wave periods were compared to those from the spectral analysis of a 3-month water level record. The results for the gravest-mode seiche were found to be in good agreement, whereas the second and third mode showed a systemic devi-ation from the observations. A sensitivity analysis of the computational procedure indicates that this discrepancy can most likely be ascribed to insufficient knowledge of the detailed topography of the lake. (Author's abstract)
W91-02593

BUGLE LAKE PROTECTION AND REHABILI-TATION PROJECT. Independence Public Inland Lake Protection and Rehabilitation District, WI. For primary bibliographic entry see Field 5G. W91-02621

WETLANDS AND GROUNDWATER: NEW CONSTRAINTS IN GROUNDWATER MANAGEMENT.

Universidad Complutense de Madrid (Spain). Dept. of Geodynamics.
For primary bibliographic entry see Field 6G.
W91-02722

FROM RAIN TO LAKE: WATER PATHWAYS AND CHEMICAL CHANGES. Oslo Univ. (Norway). Dept. of Geology. For primary bibliographic entry see Field 2K. W91-02734

TECHNOLOGY.
Goettingen Univ. (Germany, F.R.). Abt. Boden-kunde und Waldernahrung.
M. Hauhs. ECOSYSTEM MODELLING: SCIENCE OR

Journal of Hydrology JHYDA7, Vol. 116, No. 1/ 4, p 25-33, August 1990. 3 fig, 17 ref.

Descriptors: \*Acid rain, \*Acidification, \*Climatic changes, \*Ecology, \*Ecosystems, \*Model studies, Data acquisition, Data interpretation, Data requirements, Future planning, Model testing.

Recent interest in ecosystem modelling emerges from large-scale problems such as acid deposition or climatic change. Knowledge about future states of ecosystems can be based on management experi-ence and scientific observation. The former cannot or ecosystems can be bused on management experience and scientific observation. The former cannot be extrapolated outside the range of past variations in boundary conditions. Thus, the long-term changes in the chemical or physical climate require the identification of key-processes for successful model predictions. This scientific task is implicitly based on assumptions about the appropriate scale of integration in space and time. No scientific discipline exists by which these assumptions can be formally derived at the coosystem level. The example of modeling soil and water acidification is used to discuss the possible consequences of a technological or a scientific perception of the problem posed, respectively. These approaches often suffer from inconsistent treatment of their basic assumptions in the first case, and from lack of theory in the latter case. On the basis of the available data tions in the first case, and from lack of theory in the latter case. On the basis of the available data and theory the question posed remains undecided. However, there is a risk that focusing ecosystem research on technological perception becomes a self-fulfilling prophesy. (Author's abstract)

W91-02736

SOIL WATER IN THE RIPARIAN ZONE AS SOURCE OF CARBON FOR A HEADWATER STREAM.

STREAM. University Coll. of North Wales, Bangor. School of Biological Sciences. D. M. Fiebig, M. A. Lock, and C. Neal. Journal of Hydrology JHYDA7, Vol. 116, No. 1/4, p 217-237, August 1990. 6 fig, 2 tab, 53 ref.

Descriptors: \*Dissolved organic carbon, \*Geochemistry, \*Headwaters, \*Soil water, \*Stream banks, \*Streams, \*Surface-groundwater relations, Nitrogen, Solute transport, Streambeds, Wales.

A comparison of the organic chemistries of soil waters in the riparian zone and an adjacent stream at an upland site in mid-Wales was made over a period of one year. Dissolved organic carbon (DOC) distributions in riparian soil waters showed (DOC) distributions in riparian soil waters showed little temporal or spatial consistency, but concentrations almost always exceeded those in the stream (mean = 9.4 and 2.1 mg/l, respectively). Three major hydrological flow paths in the riparian zone were inferred by correlating dynamics of the organic chemistry, as well as inorganic nitrogen (ammonium and nitrate), between sampling points. A lack of any dynamic relationship between organic concentrations in saturated throughflow of the stream bank and the stream suggested an efficient immobilization of this soil water DOC within the streambed, root to its discharge into the within the streambed, prior to its discharge into the stream. Correlations for both DOC and inorganic No between the stream bank unsaturated zone and the stream suggested that, at higher flows, this soil water input could directly influence the stream. A high degree of correlation between soil water of the forest edge (6 m from the stream) and the stream suggested that some form of macroporous transfer of soil water from further back in the transfer of soil water from further back in the riparian zone would also directly influence the stream. It is concluded that the riparian zone can contribute substantial amounts of DOC to a stream ecosystem, and that the streambed must be a key area of chemical reactivity where much of this material is initially processed. (Author's abstract) W91-02747

GEOCHEMICAL CONTROL OF ALUMINIUM CONCENTRATIONS IN ACIDIFIED SURFACE

Oslo Univ. (Norway). Dept. of Chemistry. For primary bibliographic entry see Field 5B. W91-02752

PRODUCTION OF DISSOLVED DNA, RNA, AND PROTEIN BY MICROBIAL POPULA-TIONS IN A FLORIDA RESERVOIR.

University of South Florida, St. Petersburg. Dept. of Marine Science.

J. H. Paul, W. H. Jeffrey, and J. P. Cannon Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 10, p 2957-2962, October 1990. 4 fig. 29 ref. National Science Foundation Grant 8601570.

Descriptors: \*Biochemistry, \*Limnology, \*Microorganisms, \*Nucleic acids, \*Radioactive tracers, \*Reservoirs, Algal growth, Bacterial physiology, Carbon fixation, Carbon radioisotopes, Florida, Macromolecules, Phosphorus radioisotopes, Phytoplankton, Proteins.

Production of dissolved macromolecules by ambient autotrophic and heterotrophic microbial populations was measured in a eutrophic Florida reserlations was measured in a eutrophic Florida reservoir by in situ labeling with various radioactive substrates. When tritiated thymidine was used as the precursor, production of labeled dissolved DNA, RNA and protein was observed. The rate of production of labeled dissolved macromolecules was 3.1%, the rate of cellular incorporation of tritiated thymidine and the production of dissolved DNA represented 2.3% the rate of cellular DNA incorporation. Microautotrophic populations labeled with 14-C labeled sodium carbonate produced dissolved RNA and protein at rates of 0.24 and 0.11 microg of C/L/hr, or 1.8% the total rate of carbon fixation, with no measurable dissolved DNA production. In an attempt to specifically label phytoplankton DNA, samples were incubated with tritiated adenine or intracellular 32-P in the presence and absence of the photosynthetic inhibitor 3-(3,4-dichlorophenyl)-1,1-dimethylurea (DCMU). Although DCMU inhibited 14-C fixation by approximately 99%, this antimetabolite had only a slight effect on tritiated adenine incorporation and no effect on 32-Pincorporation into cellular macromolecules. Significant amounts of distion and no effect on 32-Pincorporation into cellu-lar macromolecules. Significant amounts of dis-solved DNA were produced in both tritiated ade-nine and intracellular 32-P incubations, but again DCMU had no effect on the production rates. These results indicate that actively growing popu-lations of both phytoplankton and bacterioplank-ton produced dissolved RNA and protein, while only active bacterioplankton produced measurable quantities of dissolved DNA. Dead or senescent quantities of insolved DNA. Dead of senescent phytoplankton may have produced dissolved DNA, but would not be measured in the relatively short incubations used. (Author's abstract) W91-02766

### BLACKWATER PERSPECTIVE ON RIVERINE

BLACKWATER PERSPECTIVE ON RIVERINE ECOSYSTEMS. Georgia Univ., Athens. Dept. of Zoology. J. L. Meyer. Bioscience BISNAS, Vol. 40, No. 9, p 643-651,

October 1990. 3 fig, 60 ref.

Descriptors: \*Blackwater streams, \*Ecosystems, \*Organic matter, \*River systems, Carbon cycle, Cycling nutrients, Dissolved solids, Food chains, Microorganisms, Model studies, Suspended sedi-

Streams are a vital natural resource, providing fresh water to support a growing human popula-tion as well as transport and treatment for wastewater. Blackwater rivers contain a low level of suspended sediments but a high concentration of of suspended sediments but a high concentration of dissolved organic matter. Basin-wide perspectives of rivers indicate that much of the degradation of organic matter added to streams is occurring in moderate-size channels rather than in headwaters, despite the headwaters' greater length. An expanded spatial perspective is necessary to investigate element cycling in lotic ecosystems where cycles are continuously depleted downstream by flowing water. The microbial loop is an effective pathway for recycling inorganic nutrients, as well as providing food for consumers and organic matter for nutrient regeneration. The lotic food web can be viewed as a mosaic of consumers and producers, located in the water column, the stable substrates of the blackwater river, and the unstable substrates of the blackwater river, and the unstable substrates of the rates of exchange of nutrients and organic matter between the different components of the stream ecosystem, as well as an assessment of stream ecosystem, as well as an assessment of factors controlling these links. Empirical and modnactors controlling these links. Empirical and mod-eling studies are needed to assess the significance of the microbial food web as a pathway of organic carbon transfer and nutrient spiraling in flowing waters. (Brunone-PTT) W91-02778

## MULTIPLE DEMANDS ON WETLANDS. Florida Univ., Gainesville. Dept. of Forestry. K. C. Ewel.

K. C. Ewel. Bioscience BISNAS, Vol. 40, No. 9, p 660-666, October 1990. 6 fig, 1 tab, 33 ref.

Descriptors: \*Cypress swamps, \*Ecological effects, \*Land use, \*Water level fluctuations, \*Wetlands, Competition, Evapotranspiration, Flooding, Nutrients, Population density, Population dynamics, Primary productivity, Seasonal variation, productivity,

vorld with a rapidly increasing population In a world with a rapidly increasing population and a shrinking resource base, uncontroversial land use decisions are becoming increasingly difficult. Wetlands are particularly vulnerable because they often represent the only undeveloped land in an area. Cypress swamps provide a variety of benefits, and are useful for demonstrating the kinds of landuse conflicts that may arise. Bald cypress trees are common where flowing water brings in nutrients and ameliorates reducing conditions in the soil;

pond cypress trees are common in small stillwater swamps. Water level fluctuates in all cypress swamps, and cypress seeds will not germinate under standing water. High water is necessary to reduce competition from more rapidly growing vegetation. Gross primary productivity in cypress swamps is closely related to the rate of nutrient inflow, and aboveground net primary productivity tends to be highest in swamps with intermediate hydroperiods. Because the water level in a cypress pond is generally continuous with the water flows into the swamp when heavy rainfall raises the water table, and groundwater is recharged at the end of the rainy season when water tables drop more rapidly than water levels in the ponds. In addition, cypress ponds seem to have a lower evapotranspiration rate than surrounding ecosystems, provide flood and water quality control, and serve as a source of wood. Decisions about use of tents, provide Hood and water quality control, and serve as a source of wood. Decisions about use of an individual swamp must consider its regional importance. The time course of succession must be considered, as well as the possible importance of fire to a cypress swamp. (Brunone-PTT) W91-02779

# USE OF KINETIC BIOASSAY PROCEDURE TO ESTIMATE SULFATE AND CYSTEINE CONCENTRATIONS IN SEDIMENT. Portland State Univ., OR. Environmental Sciences

D. A. Dunnette, D. P. Chynoweth, and K. H.

Mancy. Water Research WATRAG, Vol. 24, No. 11, p 1395-14000, November 1990. 2 fig, 3 tab, 27 ref. NIH Grant 5T01-EC0030 and EPA Grant 5P3-WP-177.

Descriptors: \*Amino acids, \*Bioassay, \*Cysteine, \*Eutrophication, \*Hydrogen sulfide, \*Limnology, \*Nutrients, \*Path of pollutants, \*Sediment chemistry, \*Sulfates, Kinetics, Lake sediments, Michaelis-Menten model, Putrefaction, Tracers.

There are often difficulties in estimating the bioa-There are often difficulties in estimating the bioa-vailability of essential nutrients and energy sources for aquatic microorganisms involved in mediating key sedimentary biotransformations. In order to estimate rates of sulfate reduction and putrefaction in sedimentary hydrogen sulfide production, a ki-netic bioassay procedure was utilized to confirm the concentrations of hydrogen sulfide precursors determined by standard analytical procedures. S35-labeled sulfate and cyteins were added searcately the concentrations of hydrogen sulfinde precursors determined by standard analytical procedures. S35-labeled sulfate and cysteine were added separately to freshwater lake sediment which had been transferred to plastic disposable syringes and incubated at 10 °C for 2 h. Substrate depletion during the 2 h incubation ranged from approx. 1 to 5%. Final labeled plus unlabeled concentrations of sulfate and cysteine varied from 4.3 to 12.3 and 2.2 to 5.6 mg S/L, respectively. Precision of the method was +/-15%. The results were suggestive but inconclusive that sulfide production via sulfate reduction and putrefaction adhere to the Michaelis-Menten kinetic model. Nevertheless, the kinetic bioassay procedure of Wright and Hobbie appears to be useful in estimating substrate bioavailability for cysteine and sulfate and perhaps other sedimentary substrates. In addition, the method permits reliable tracer estimates of sulfide production in freshwaters with low sulfate concentrations which might otherwise not be possible. (White-Reimer-PTT)

# CONTROLS AND EFFECTS OF CONTINEN-TAL BRINE FORMATION IN A SUPRATIDAL EPHEMERAL LAKE IN THE SEMI-ARID EN-VIRONMENT OF SPENCER GULF, SOUTH

AUSTRALIA.
Commonwealth Scientific and Industrial Research
Organization, Canberra (Australia). Div. of Water
and Land Resources.

Australian Journal of Earth Sciences AJESE7, Vol. 37, No. 1, p 71-84, March 1990. 9 fig, 4 tab, 54

Descriptors: \*Australia, \*Coasts, \*Ephemeral lakes, \*Saline lakes, \*Saline-freshwater interfaces, \*Semiarid lands, \*Tide lands, Brines, Cyanophyta,

Gypsum, Isotope studies, Marine environment, Metals, Oxidation-reduction potential, Spencer Gulf, Sulfates, Sulfides.

Gulf, Sulfates, Sulfides.

Ephemeral saline lakes form along the eastern shore of Spencer Gulf, in semiarid southern Australia, where beach ridges isolate areas of the high supratidal zone. Lacustrine sediments studied contain abundant discoidal gypsum. Isotope distributions and ion ratios indicate that groundwater from landward of and within the lake is non-marine in origin. The marine-terrestrial groundwater interface is mobile; after heavy rain, continental-derived brines flow seaward as far as the high intertidal zone. Within the lake, seasonal changes result in alternate desiccation and flooding by mildly actic and oxidizing waters. The consequent variability in salinity and redox conditions is inimical to sustained biological activity or sulfide preservation. During dry periods, a halite crust forms on the surface and, as anaerobic conditions and bacterial sulfate reduction are established, iron sulfides precipitate in the vadose sediments. However, when water table levels rise, cyanobacteria colonize wetted surface sediments and the iron sulfides become oxidized. Mobilization of Zn indicates that metals can be transported in the oxidized brines, but such an environment usually due forcer, their become oxidized. Mobilization of Zn indicates that metals can be transported in the oxidized brines, but such an environment would not favor their preservation as sulfides. The lake is most notable for its gypsum formation and can be differentiated from other well-documented sites in that both the water and the sulfate ions have continental signatures despite the proximity to marine-influenced zones. These coastal, gypsiferous, ephemeral lakes are more akin to a continental playa but with some acolian influences, and thus extend the spectrum of coastal sabkha-like environments, particularly as a consequence of the semiarid climate. (Author's abstract) stract) W91-02806

## SEASONAL CHANGES IN IRON TRANSPORT AND NATURE OF DISSOLVED ORGANIC MATTER IN A HUMIC RIVER IN NORTHERN

Oulu Univ. (Finland). Dept. of Botany. For primary bibliographic entry see Field 2K. W91-02810

### OBSERVATIONS OF THE NIAGARA RIVER THERMAL PLUME (LAKE ONTARIO, NORTH

National Water Research Inst., Burlington (Ontar-io). Lakes Research Branch. For primary bibliographic entry see Field 2E. W91-02832

### SEASONAL DYNAMICS IN METHANE EMISSIONS FROM THE AMAZON RIVER FLOOD-PLAIN TO THE TROPOSPHERE.

Washington Univ., Seattle, School of Oceanogra-

phy. A. H. Devol, J. E. Richey, B. R. Forsberg, and L.

A. Martinelli.

Journal of Geophysical Research (D) Atmospheres

JGRDE3, Vol. 95, No. 10, p 16,417-16,426, Sep
tember 10, 1990. 5 fig. 3 tab, 64 ref. NSF Grant

Nos. BSR-83-16399 and BSR-87-18423; NASA

Grant No. NAGW-1066.

Descriptors: \*Amazon River Basin, \*Atmospheric chemistry, \*Flood plains, \*Methane, \*Seasonal variation, Air pollution, Annual floods, Aquatic plants, Flooding, Lakes, Macrophytes, Tropical regions, Water level.

Methane fluxes to the troposphere from the three principal habitats of the floodplain of the Amazon River main stem (open waters, emergent macrophyte beds, and flooded forests) were determined along a 1700-km reach of the river during the low water period of the annual flood cycle (November-December 1988). Overall, emissions averaged 68 mg CH4 and were significantly lower than similar emissions determined previously for the high water period, 184 (+/-41) mg CH4/sq m/d. This difference was due to significantly lower emissions from floating macrophyte environments. Low water emissions from open waters and flooded forest

### Field 2—WATER CYCLE

### Group 2H-Lakes

areas were not significantly different than at high water. A monthly time series of methane emissions water. A monthly time series of methane emissions from eight lakes located in the central Amazon Basin showed similar results. Average annual emission from the lakes was 125 (+/-28) mg CH4/sq m/day. Methane emissions from lakes were significantly higher during the high water period, again, primarily due to an increase in emissions from macrophyte habitats. The data were used to calculate a seasonally weighted annual emission to the troposphere from the Amazon River main stem floodplain of 5.1 Tg/yr which indicates the importance of the area in global atmospheric chemistry. (See also W91-02837) (Author's abstract) W91-02837) (Author's abstract)

METHANE FLUX FROM THE AMAZON RIVER FLOODPLAIN: EMISSIONS DURING RISING WATER.

RISING WATER.
College of William and Mary, Williamsburg, VA.
Dept. of Biology.
K. B. Bartlett, P. M. Crill, J. A. Bonassi, J. E.
Richey, and R. C. Harriss.
Journal of Geophysical Research (D) Atmospheres
JGRDE3, Vol. 95, No. 10, p 16,773-16,788, September 20, 1990. 8 fig. 4 tab, 66 ref.

Descriptors: \*Amazon River Basin, \*Atmospheric chemistry, \*Flood plains, \*Methane, \*Seasonal variation, Air pollution, Aquatic plants, Fluctua-tions, Tropical regions, Water level, Wetlands.

During April and May 1987, an extensive methane During April and May 1987, an extensive metnane flux data set from Amazonian wetland habitats was collected during the wet season as river water levels were high and rising. This work extended measurements made in the dry season of 1985, when water levels were falling. Comparisons between these two data sets allows the estimation of the amount of seasonal variability in this globally significant source of tropospheric methane. A total the amount of seasonal variability in this globally significant source of tropospheric methane. A total of 284 flux measurements were made in the three primary floodplain environments of open water lakes and channels, floating grass mats, and flooded forests, along approximately 1500 km of the central floodplain. Emissions (means and standard errors) were 74 +/-14 mg CH4/sq m/d (open water), 201 +/-35 mg CH4/sq m/d (grass mats), and 126 +/-20 mg CH4/sq m/d (flooded forests). These values were not significantly different from the majority of those from 1985, due in part to the high variability in flux seen at both times. Although ebullition was a significant component of though ebullition was a significant component of methane emissions at both periods, the frequency of bubbling and its contribution to total flux was lower during the period of rising water than of falling water. A prominent diurnal pattern in at-mospheric methane concentrations was observed, with minimum levels of about 1.75 ppm at midday and a maximum of 2.12 ppm at around midnight with minimum levels of about 1.75 ppm at midday and a maximum of 2.12 ppm at around midnight. Given the relatively small seasonal changes observed in flux at the two stages of the rivers hydrographic curve, earlier estimates of regional methane flux remain largely unchanged. Revision of global estimates of wetland methane sources based on these tropical data and recently published figures for northern peatlands indicated that tropical wetlands may be more important than previously suggested, but that wetland sources overall remain at approximately 110 Tg/yr. (See also W91-02834) (Author's abstract)

ESTIMATING GROUNDWATER EXCHANGE WITH LAKES: 1. THE STABLE ISOTOPE MASS BALANCE METHOD.

Geological Survey, Madison, WI. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-02873

ESTIMATING GROUNDWATER EXCHANGE WITH LAKES: 2. CALIBRATION OF A THREE-DIMENSIONAL, SOLUTE TRANSPORT MODEL TO A STABLE ISOTOPE PLUME. Geological Survey, Madison, WI. Water Resources Div.

For primary bibliographic entry see Field 2F.

SIMULATION OF LAKE EVAPORATION WITH APPLICATION TO MODELING LAKE LEVEL VARIATIONS OF HARNEY-MAL-HEUR LAKE, OREGON.

HEUR LARE, URREGON.
Geological Survey, Denver, CO.
S. W. Hostetler, and P. J. Bartlein.
Water Resources Research WRERAQ, Vol. 26,
No. 10, p. October 1990. 14 fig. 40 ref. Department of Energy Grant DEFG02-85ER60304.

Descriptors: \*Climatic changes, \*Hydrologic cycle, \*Lake evaporation, \*Oregon, \*Water level fluctuations, Closed basins, Eddy diffusion, Evaporation, Hydrologic models, Water temperature.

The hydrologic balance of a lake represents a direct response to prevailing climatic conditions in unregulated lake basins. Evaporation is a primary path for water loss from most lakes; therefore in order to assess the relation between climatic vari-ations and fluctuations in the size of a lake a ations and fluctuations in the size of a lake a method for estimating evaporation rates that is sensitive to climatic variations is required. A physically based eddy diffusion model can stimulate the seasonal variation in lake temperature and evaporation. Because no lake-specific fitting of the parameters of the model is necessary, the model can be used to simulate evaporation in studies of climate change and lake hydrology in a variety of settings. The eddy diffusion model is used to simulate evaporation for input to a simple lake level model that is applied to reconstruct recent fluctuations in the ne eduy diffusion model is used to simulate evaporation for input to a simple lake level model that is applied to reconstruct recent fluctuations in the level of Harney-Malheur Lake, in the high desert of southeastern Oregon, caused by climatic variations. Beginning in 1982, an increase in effective moisture throughout the Harney-Malheur basin caused the lake to rise over 2 m and attain a depth of more than 4 m during 1984 and 1985. The meteorologici input data for the thermal model and the hydrological data for the lake level model either were obtained from observations or were estimated. Monthly values of the meteorological data were fitted with cubic splines to derive daily input values. The observed fluctuations in lake level were accurately reproduced by the lake level model. Because the model is sensitive to the climatic input variables, it can provide a tool for investigating the response of lake level to climate change. (Author's abstract)

METAL-ORGANIC ASSOCIATIONS IN SEDI-MENTS-II, ALGAL MATS IN CONTACT WITH GEOTHERMAL WATERS.

Munich Univ. (Germany, F.R.). Mineralogisch-Petrographisches Inst. For primary bibliographic entry see Field 2J. W91-02892

RECOVERY OF LOTIC COMMUNITIES AND ECOSYSTEMS FROM DISTURBANCE--A NAR-RATIVE REVIEW OF CASE STUDIES. Environmental Research Lab., Duluth, MN. For primary bibliographic entry see Field 5G. W91-02897

RECOVERY OF LOTIC PERIPHYTON COM-MUNITIES AFTER DISTURBANCE, Oak Ridge National Lab., TN. Environmental Sci-

A. D. Steinman, and C. D. McIntire A. D. Steinman, and C. D. McIntire. Environmental Management EMNGDC, Vol. 14, No. 5, p 589-604, 1990. 1 tab, 120 ref. NSF Inter-agency Agreement 40-689-78 with the DOE under Contract DE-AC05-840R21400.

Descriptors: \*Ecological effects, \*Ecosystems, \*Habitat restoration, \*Lotic environment, \*Periphyton, \*Rehabilitation, \*Restoration, \*Stream biota, \*Water pollution effects, Bioindicators, Cycling nutrients, Dehydration, Floods, Metals, Nu-

Periphyton communities represent potentially ex-cellent candidates for assessing the recovery of lotic ecosystems after disturbance. These commu-nities are ubiquitous, relatively easy to sample and measure (in terms of total community biomass), have short generation times, and may influence the recovery rates of higher trophic levels. The first section of the article analyzes how site availability, species availability, and differential species performance influence periphyton successional dynamics. This background information provides a foundation for understanding how periphytic orga-nisms respond after a disturbance. The second section of the article analyzes how periphyton com-munities respond to four different types of disturbmunities respond to four different types of disturb-ance (flood events, dessication, organic nutrient enrichment, and toxic metal exposure). Although data are limited, it is concluded that the fast growth rates and short generation times of peri-phytic organisms, coupled with their flexible life history strategies and good dispersal ability. phytic organisms, coupled with their flexible life history strategies and good dispersal ability, allow lotic periphyton communities to recover relatively quickly after a disturbance. In addition, disturbance type and severity, local environmental conditions, and site specific factors also will influence recovery rates. Future research needs include a better understanding of: (1) what periphyton properties would serve as the best index of recovery (2) whether or not the robustness of this index varies among different environments and different and influence and influenc varies among different environments and different disturbances; (3) interactions between autotrophs and heterotrophs within the periphyton mat, particularly with respect to nutrient cycling; (4) competitive interactions among organisms; (5) func-tional redundancy of organisms; and (6) the influence of the riparian zone and channel geomorphology on periphyton recovery rates. (Author's ab-W91-02899

RECOVERY OF LOTIC MACROINVERTE-BRATE COMMUNITIES FROM DISTURB-ANCE.

Georgia Univ., Athens. Dept. of Entomology. J. B. Wallace.

Environmental Management EMNGDC, Vol. 14, No. 5, p 605-620, 1990. 3 fig, 1 tab, 135 ref. NSF Grant Nos. BSR83-16082, BSR87-18005, and BSR85-16497.

Descriptors: \*Ecosystems, \*Habitat restoration, \*Lotic environment, \*Macroinvertebrates, \*Rehabilitation, \*Stream biota, \*Water pollution effects, Ecological effects, Ecotoxicology, Life history studies, Pesticides, Recolonization, Toxicity.

Ecosystem disturbances produce changes in macrobenthic community structure (abundances, biomass, and production) that persist for a few weeks to many decades. Examples of disturbances with extremely long-term effects on benthic communities include contamination by persistent toxic agents, physical changes in habitats, and altered energy inputs. Stream size, retention, and local geomorphology may ameliorate the influence of disturbances on invertebrates. Disturbances can alter food webs and may select for favorable genotypes (e.g., insecticidal resistance). The introduction of pesticides into lotic ecosystems, which do not result in major physical changes within habinot result in major physical changes within habi-tats, illustrate several factors that influence inverte-brate recovery time from disturbance. These inbrate recovery time from disturbance. These in-clude: (1) magnitude of original contamination, toxicity, and extent of continued use; (2) spatial scale of the disturbance; (3) persistence of the pesticide: (4) timing of the contamination in rela-tion to the life history stages of the organisms; (5) vagility of populations influenced by pesticides; and (6) position within the drainage network. The ability of macroinvertebrates to recolonize denud-el steam habitats may have greatly depending on ed stream habitats may vary greatly depending on regional life histories, dispersal abilities, and posiregional life instories, dispersal abilities, and posi-tion within the stream network. Although down-stream drift is the most frequently cited mechanism of invertebrate recolonization following disturb-ance in middle and larger-order streams, evidence is shown which shows aerial recolonization to be is shown which shows aerial recolonization to be potentially important in headwater streams. There is an apparent stochastic element operating for disturbance and flight periods of various taxa. Available evidence indicates that recolonization of invertebrate taxa without an aerial adult stage requires longer periods of time than for those that possess winged, terrestrial adult stages (most insects). Innovative, manipulative experiments are needed in order to address recolonization mecha-nisms of animals inhabiting streams that differ in

size, latitude, disturbance frequency and magni-tude, as well as the potential influence of early colonists on successional sequences of species fol-lowing disturbance. (Author's abstract) W91-02900

ENVIRONMENTAL VARIATION, LIFE HISTORY ATTRIBUTES, AND COMMUNITY STRUCTURE IN STREAM FISHES: IMPLICATIONS FOR ENVIRONMENTAL MANAGEMENT AND ASSESSMENT.
NORTH DAKOTA DIAGRAM.

ogy.
I. J. Schlosser.
Environmental Management EMNGDC, Vol. 14,
No. 5, p 621-628, 1990. 3 fig. 3 tab, 45 ref. EPA
Grant No. R806391; NSF Grants BSR8320371 and

Descriptors: \*Ecosystems, \*Environmental policy, \*Life history studies, \*Stream fisheries, \*Water pollution effects, Biological studies, Downstream, Ecological effects, Fish behavior, Monitoring, Temporal distribution, Upstream.

Fishes in midwestern streams of the United States experience strong upstream-downstream gradients in natural environmental variability. Upstream in natural environmental variability. Opstream fishes experience greater temporal variability in physical-chemical conditions than downstream fishes. As a whole, upstream species have a shorter life span, smaller body size, and earlier sexual life span, smaller body size, and earlier sexual maturity than downstream species. Descriptive studies also suggest upstream species exhibit more rapid recolonization after severe physical disturbance than downstream species, and fish community structure is temporally more variable in upstream than downstream areas. These longitudinal differences in life history characteristics suggest that upstream fish communities will exhibit a more rapid recovery from severe anthropogenic disturbances than downstream fish communities. The greater temporal variability of fish community structure in upstream areas also suggests it will be more difficult in upstream than downstream areas to use fish based indices to distinguish whether more difficult in upstream than downstream areas to use fish based indices to distinguish whether subtle changes in environmental quality are due to natural or anthropogenic disturbances. Long-term monitoring of fishes throughout drainage basins is critically needed to establish more precisely the natural range of variation in community structure. Such monitoring will allow regulatory agencies to distinguish, with greater confidence, the influence of anthropogenic disturbances on stream fishes from the influence of natural environmental variation. (Author's abstract)

PHYSICAL HABITAT TEMPLATE OF LOTIC SYSTEMS: RECOVERY IN THE CONTEXT OF HISTORICAL PATTERN OF SPATIOTEM-PORAL HETEROGENEITY.

do State Univ., Fort Collins. Dept. of Biol-

ogy. N. L. Poff, and J. V. Ward.

Environmental Management EMNGDC, Vol. 14, No. 5, p 629-645, 1990. 3 fig, 1 tab, 128 ref.

Descriptors: \*Ecological effects, \*Habitat restora-tion, \*Heterogeneity, \*Lotic environment, \*Reha-bilitation, \*Stream biota, Ecosystems, Habitas, Spatial distribution, Streams, Temporal distribution. Water pollution effects.

Spatial and temporal environmental heterogeneity in lotic ecosystems can be quantitatively described and identified with characteristic levels of ecologiand identified with characteristic levels of ecologi-cal organization. The long-term pattern of physico-chemical variability in conjuction with the com-plexity and stability of the substratum, establishes a physical habitat template that theoretically influ-ences which combinations of behavioral, physio-logical, and life history characteristics constitute appropriate ecological strategies for persistence in the habitat. Physical habitat templates and associat-ecological attribute differ areaspatically. the habitat. Physical habitat templates and associative de ecological attributes differ geographically because of biogeoclimatic processes that constrain lotic habitat structure and stability, and that influence physiochemical variability and disturbance patterns (frequency, magnitude, and predictability). Theoretical considerations and empirical studies.

ies suggest that recovery from natural and anthropogenic disturbances also will vary among lotic systems, depending on historical temporal variability regime, degree of habitat heterogeneity, and spatial scale of the perturbation. Characterization of physical habitat templates and associated ecological dynamics along gradients of natural disturbance would provide a geographic framework by predicting recovery from anthropogenic disturbance for individual streams. Description of lotic environmental templates at the appropriate spatial and temporal scale is therefore desirable to test theoretical expectations of biotic recovery rate from disturbance, and to guide selection of appropriate reference study sites for monitoring impacts of anthropogenic disturbance. Historical streamflow data, coupled with stream-specific thermal and substratem-geomorphologic characteristics, and substratem-geomorphologic characteristics, are suggested as minimum elements needed to characterize physical templates of lotic systems. (Author's abstract)
W91-02902

DISTURBANCE REGIMES, RESILIENCE, AND RECOVERY OF ANIMAL COMMUNITIES AND HABITATS IN LOTIC ECOSYSTEMS. North Carolina Univ. at Chapel Hill. Dept. of

Biology.

S. R. Reice, R. C. Wissmar, and R. J. Naiman.
Environmental Management EMNGDC, Vol. 14,
No. 5, p 647-659, 1990. 7 fig, 114 ref.

Descriptors: \*Ecological effects, \*Ecosystems, \*Habitat restoration, \*Habitats, \*Lotic environment, \*Stream biota, Algae, Aquatic environment, Bank erosion, Channelization, Erosion, Scour, Sediment transport, Sedimentation, Spatial dynam-

Disturbance regime is a critical organizing feature of stream communities and ecosystems. The position of a given reach in a river basin and the sediment type within that reach are two key determinants of the frequency and intensity of flow induced disturbances. The differences between predictable and unpredictable events are considered; it is suggested that predictable discharge events are not disturbances. The most frequently and predictably disturbed sites can be expected to demonstrate the highest resilience. Spatial scale is an important dimension of community structure, dynamics, and dimension of community structure, dynamics, and recovery from disturbance. The effects on small patches (< 1 sq m) were compared to the effects of large reaches at the river basin level. At small on large reaches at the river basin level. At small scales, sediment movements and scour are major factors affecting the distribution of populations of aquatic insects or algae. At larger scales, channel formation, bank crossion, and interactions with the riparian zone that will affect all taxa and processes must be accompand. An understanding of riparian zone that will affect all taxa and processes must be examined. An understanding of stream ecosystem recovery rests on an understanding of the historical, spatial, and temporal background of contemporary disturbance events. (Author's abstract) W91-02903

ASSEMBLAGE STABILITY IN STREAM FISHES: A REVIEW.
Georgia Univ., Athens. School of Forest Re-

sources.

G. D. Grossman, J. F. Dowd, and M. Crawford.
Environmental Management EMNGDC, Vol. 14,
No. 5, p 661-671, 1990. 4 fig. 9 tab, 46 ref. McIntire-Stennis Grant No. GEO-0035-MS.

Descriptors: \*Literature review, \*Population dynamics, \*Stream biota, \*Stream fisheries, \*Water pollution effects, Baseline studies, Ecological efects, Ecosystems, Fish populations, Species composition, Statistical studies, Variation coefficient.

The stability of nine fish stream assemblages were The stability of nine fish stream assemblages were quantified by calculating coefficients of variation of population size for assemblage members. Coefficients of variation were high and averaged over 96%, indicating that most assemblages were quite variable. Coefficients of variation (CV) estimates were not significantly affected by: (1) years of study, (2) mean abundance, (3) familial classification, or (4) mean interval between collections. Minor regional differences were also detected in

CVs. The high variability exhibited by many stream fish assemblages suggest that it may be difficult to detect the effects of anthropogenic disturbances using population data alone; consequently, caution is urged when evaluating the effects of these disturbances. Many long-term studies of the ecological characteristics of undisturbed stream fish assemblages are needed to provide a benchmark against which disturbed systems can be compared. CVs are a better estimator of population/ assemblage stability than either Kendall's W or the standard deviation of the logarithms of numerical censuses. This conclusion is based on the following reasons: (1) CVs scale population variation by the reasons: (1) CVs scale population variation by the reasons: (1) CVs scale population variation by the mean and, hence, more accurately measure population variability; and (2) this scaling permits the comparison of populations with different mean abundances. Finally, the interpretation of CV values is less ambiguous than either of the aforementioned metrics. (Author's abstract) W91-02904

REGIONAL FRAMEWORK FOR ESTABLISH-ING RECOVERY CRITERIA.

NSI Technology Services Corp., Corvallis, OR. R. M. Hughs, T. R. Whittier, C. M. Rohm, and D. P. Larsen.

P. Laisen.
Environmental Management EMNGDC, Vol. 14, No. 5, p 673-683, 1990. 7 fig, 44 ref. EPA Contract No. 68-C8-0006.

Descriptors: \*Aquatic environment, \*Habitat restoration, \*Lotic environment, \*Resources management, \*Stream fisheries, Arkansas, Case studies, Ecosystems, Management planning, Montana,

Effective assessments of aquatic ecosystem recovery require ecologically sound endpoints against which progress can be measured. Site by site assessments of endpoints and potential recovery trajectories are impractical for water resources agencies. Because of the natural variation among ecocies. cies. Because of the natural variation among ec-systems, applying a single set of criteria nationwide is not appropriate either. The use of a regional framework for stratifying natural variation and for determining realistic biological criteria was examined. A map of ecoregions, drawn from landscape characteristics, formed the framework of three statewide case studies and three separate studies at the river basin scale. Statewide studies of Arkanthe river basin scale. Statewide studies of Arkan-ass, Ohio, and Oregon, streams demonstrated pat-terns in fish assemblages corresponding to ecore-gions. The river basin study in Oregon revealed a distinct change at the ecoregion boundary; those in Ohio and Montana demonstrated the value of regional reference site for assessing recovery. Ecore-gions can be used to facilitate the application of gions can be used to facilitate the application of ecological theory and to set recovery criteria for various regions of states or of the country. Such a framework provides an important alternative between site specific and national approaches for assessing recovery rates and conditions. (Author's abstract) W91-02905

BIOGEOCHEMICAL CYCLING CON-STRAINTS ON STREAM ECOSYSTEM RE-

Oak Ridge National Lab., TN. Environmental Sciences Div.

ences Div.

D. L. DeAngelis, P. J. Mulholland, J. W. Elwood,
A. V. Palumbo, and A. D. Steinman.

Environmental Management EMNGDC, Vol. 14,
No. 5, p 685-697, 1990. 4 fig, 6 tab, 42 ref. NSF

Ecosystems Study Agreement No. 40-689-78;

DOE Contract No. DE-AC05-840R21400.

Descriptors: \*Biogeochemistry, \*Cycling nutrients, \*Ecosystems, \*Limiting nutrients, \*Lotic environment, \*Model studies, \*Stream biota, Ecological effects, Equilibrium, Floods, Grazing, Mathematical models, Nutrients, Periphyton, Population dynamics, Restoration, Scour, Snails.

In systems where production is limited by the availability of a nutrient, nutrient input to and recycling within the system is related to the resilence, or speed of recovery, of a system to its steady state following a disturbance. In particular,

### Group 2H-Lakes

it is shown that the return time of the system to a steady state, or the inverse of the resilience, is approximately equal to the mean turnover time of the limiting nutrient in the system. From this relationship it is possible to understand and predict how various properties of food webs and their environments affect resilience. These properties include nutrient input rate, loss rate, size of the detritus compartment, and trophic structure. The effects of these properties on resilience are described by using simple mathematical models. To test model predictions, experimental studies of the response of periphyton-dominated stream ecosystems to disturbance are being conducted on a set of laboratory streams in which nutrient inputs and grazing intensity are regulated at different levels. In streams without snall grazers (low-grazed streams), 90% recirculation of stream water to reduce nutrient inputs resulted in longer turnover times of phosphorous within the stream compared with once-through flow. However, in streams with snall grazers (high-grazes streams) there were no differences in phosphorous turnover time between once-through and partially recirculated treatments. Results on the rate of recovery of periphyton from a flood/scour disturbance to each stream partially support the model prediction of a positive relationship between ecosystem return time and nutrient turnover time within the streams. (Author's abstract)

DISTURBANCE AND RECOVERY OF LARGE FLOODPLAIN RIVERS.

Illinois Natural History Survey, Havana. Stephen A. Forbes Biological Station.

R. E. Sparks, P. B. Bayley, S. L. Kohler, and L. L. Osborne.

Environmental Management EMNGDC, Vol. 14, No. 5, p 699-709, 1990. 5 fig. 1 tab, 30 ref. NSF Grant Nos. BSR-8114563 and BSR-8612107.

Descriptors: \*Ecological effects, \*Ecosystems, \*Flood flow, \*Flood plains, \*Illinois River, \*Mississippi River, \*River basins, Annual floods, Aquatic plants, Drought, Flooding, Habitat restoration, Runoff, Suspended sediments, Turbidity, Vegetation.

Disturbance in a river-floodplain system is defined as an unpredictable event that disrupts structure or function at the ecosystem, community or population level. Disturbance can result in species replacements or losses, or shifts of ecosystems from one persistent condition to another. A disturbance can be a discrete event or a graded change in a controlling factor that eventually exceeds a critical threshold. The annual flood is the major driving variable that facilitates lateral exchanges of nutrients, organic matter, or organisms. The annual flood is not normally considered a disturbance unless its timing or magnitude is atypical. The record flood of 1973 had little effect on the biota at a long-term study site on the Mississippi River, but the absence of a flood during the 1976-1977 Midwestern drought caused short and long-term changes. Body burdens of contaminants increased temporarily in key species, because of increased concentration resulting from reduced dilution. Reduced runoff and sediment input improved light penetration and increased the depth at which aquatic macrophytes could grow. Developing plant beds exerted a high degree of biotic control and were able to persist, despite the resumption of normal floods and turbidity in subsequent years. In contrast to the discrete event that disturbed the Mississippi River, a major confluent, the Illinois River, has been dega.ded by a gradual increase in sediment input and sediment resuspension. From 1938-1961 formerly productive backwaters and lakes along a 320 km reach of the Illinois River changed from clear, vegetated areas to turbid, barren basins. The change to a system largely controlled by abiotic factors was rapid and the degraded condition persists. Greater use should be made of man made or natural disturbances and environmental restoration as opportunistic experiments to measure thresholds and monitor the recovery process. (Lantz-PTT)

ROLE OF REFUGIA IN RECOVERY FROM DISTURBANCES: MODERN FRAGMENTED AND DISCONNECTED RIVER SYSTEMS. Pacific Northwest Forest and Range Experiment Station, Corvallis, OR. Forestry Sciences Lab. J. R. Sedell, G. H. Reeves, F. R. Hauer, J. A. Stanford, and C. P. Hawkins.

Stantord, and c. P. Hawwins.
Environmental Management EMNGDC, Vol. 14,
No. 5, p 711-724, 1990. 1 fig, 2 tab, 80 ref. NSF
Grant Nos. BSR-8414325, BSR-8508356, BSR8416127, and BSR-8705269.

Descriptors: \*Habitat restoration, \*Refugia, \*River systems, \*Stream biota, Detritus, Flood plains, Research priorities, Riparian vegetation, River channels, Surface-groundwater relationships.

Habitats and environmental factors that convey spatial and temporal resistance and/or resilience to biotic communities that have been impacted by biophysical disturbances may be called refugia. Most refugia in rivers are characterized by extensive coupling of the main channel with adjacent streamside forests, floodplain features, and groundwater. These habitats operate at spatial scales, from localized particles, to channel units such as pools and rifles, to reaches and longer sections, and at the basin level. A spatial hierarchy of different physical components of a drainage network is proposed to provide a context for the different refugia. Examples of refugia operating at different spatial scales, such as pools, large woody debris, floodplains, below dams, and catchment basins are discussed. It is recommend that several research sites established within ecoregions of the United States. These demonstration sites would be dedicated to understanding processes, including spatial and temporal dynamics of refugia, that control biodiversity and the functional integrity of river ecosystems. (Lantz-PTT) W91-02908

RECOVERY PROCESSES IN LOTIC ECOSYS-TEMS: LIMITS OF SUCCESSIONAL THEORY. Arizona State Univ., Tempe. Dept. of Zoology. S. G. Fisher.

Arizona State Only, Tempe. Dept. of Zoology. S. G. Fisher.
Environmental Management EMNGDC, Vol. 14, No. 5, p 725-736, 1990. 1 fig, 3 tab, 79 ref. NSF Grant Nos. BSR-8406891 and BSR-88-18612.

Descriptors: \*Habitat restoration, \*Lotic environment, \*Stream biota, \*Succession, Climates, Ecosystems, Life history studies, Streams.

The concept of succession has a distinguished history in general ecology and has applied to stream ecosystems with some success. Succession in streams is largely secondary, follows initial floristics models, and occurs through a variety of mechanisms. The process is moderately predictable and highly influenced by climatic factors, particularly nutrient chemistry. In desert streams, succession does not result in a climax state. While evidence is slim, succession may not be a significant process in steams of certain types or in certain regions. Successional theory is difficult to apply to spatially heterogeneous, hierarchically organized ecosystems. It also suffers in being only one component of a better integrated concept, that of ecosystems ability, which deals more directly with disturbance and ecosystem resistance in addition to resilience (which encompasses succession). Succession has as o suffered from a half century of confusion that a strong case can be made for abandoning the term, at least as it applies in streams, in favor of a broader view provided by the stability theory. (Author's abstract) W91-02909

APPLICATION OF ECOLOGICAL THEORY TO DETERMINING RECOVERY POTENTIAL OF DISTURBED LOTIC ECOSYSTEMS: RE-SEARCH NEEDS AND PRIORITIES.

SEARCH NEEDS AND PRIORITIES, Austin Peay State Univ., Clarksville, TN. Center for Field Biology. J. A. Gore, J. R. Kelly, and J. D. Yount. Environmental Management EMNGDC, Vol. 14, No. 5, p 755-762, 1990. 37 ref. Cornell University and EPA Cooperative Agreement No. CR812685.

and EPA Cooperative Agreement No. CR812685.

Descriptors: \*Ecological effects, \*Ecosystems, \*Habitat restoration, \*Lotic environment, \*Re-

search priorities, Heterogeneity, Monitoring, Spatial variation, Species diversity, Stream biota, Theoretical analysis.

Views of aquatic scientists who gathered to assess the ability of stream ecosystem theory to predict recovery from disturbance are summarized. Two views of disturbance were evident: a discrete removal of organisms versus an unusual deviation from normal. These were perceived as applying to different scales and/or objectives. Long-term information is required from both points of view to define recovery. Recovery has both spatial and temporal components, and includes both physical and biological processes. Consensus was very strong that a major role for theory lies in the understanding of spatial aspects, temporal scales, coupling of physics and biology, and the interaction of these features in recovery processes. Some progress is evident, but among the topics identified as critical were: homo-versus heterogeneous distribution of disturbance, local extent of disturbance relative to regional context, critical vs. noncritical patches (size and location) of disturbance at different spatial scales and temporal frequencies, delineation of reversible and nonreversible processes, and physical and biological constraints on the time frame for recovery. Such concepts need attention across different types of lotic ecosystems. There was a strong consensus that a national monitoring system of representative lotic ecosystems within ecological regions be established. The purpose of his monitoring system would be to acquire long-term data on natural variability, to establish viable indicators of spatial and temporal aspects of recovery, and to develop and test emerging theoretical developments. (Author's abstract)

STUDY ON THE HYDROLOGY AND PHYTO-PLANKTON OF THE VARANO LAKE (ADRI-ATIC SEA) DURING AN ANNUAL CYCLE (MAY 1985-APRIL 1986). (ETUDE SUR LAC DE VARANO (MER ADRIATIQUE): MAI 1985-AVRIL 1986).

Padua Univ. (Italy). Dept. of Biology. For primary bibliographic entry see Field 2L. W91-02934

ASIATIC CLAM, CORBICULA SPP., AS A BIO-LOGICAL MONITOR IN FRESHWATER ENVI-RONMENTS.

Syracuse Research Corp., NY. Aquatic Toxicology Lab. For primary bibliographic entry see Field 5A. W91-02944

### 2I. Water In Plants

SCREENING FOR DROUGHT TOLERANCE: SOYBEAN GERMINATION AND ITS RELA-TIONSHIP TO SEEDLING RESPONSES. Alabama A and M Univ., Normal. Dept. of Plant and Soil Science. For primary bibliographic entry see Field 3F. W91-02074

INFLUENCE OF PLANT WATER STRESS ON NET PHOTOSYNTHESIS AND LEAF AREA OF TWO MAIZE (ZEA MAYS L.) CULTIVARS. Orange Free State Univ., Bloemfontein (South Africa). Faculty of Agriculture. For primary bibliographic entry see Field 3F. W91-02075

METHODS USED FOR CALCULATION OF PLANT AVAILABLE WATER IN NORDIC TILL SOILS.

Copenhagen Univ. (Denmark). For primary bibliographic entry see Field 2G. W91-02170

STATUS AND DISTRIBUTION OF FORESTED WETLANDS IN TROPICAL SOUTH AMERICA. Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.).

### Erosion and Sedimentation—Group 2J

For primary bibliographic entry see Field 2H. W91-02477

VENEZUELAN FLOODPLAIN STUDY ON

THE ORINOCO RIVER.

Fundacion La Salle de Ciencias Naturales, San
Felix (Venezuela). Estacion Hidrobiologica de

For primary bibliographic entry see Field 2H. W91-02478

WETLAND AND UPLAND FOREST ECOSYSTEMS IN PERUVIAN AMAZONIA: PLANT SPECIES DIVERSITY IN THE LIGHT OF SOME GEOLOGICAL AND BOTANICAL EVI-

DENCE.
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Lima (Peru). Mission ORSTOM au Perou.
For primary bibliographic entry see Field 2H. W91-02479

FLUVIAL DYNAMICS AND SUCCESSION IN THE LOWER UCAYALI RIVER BASIN, PERUVIAN AMAZONIA. Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Lima (Peru). Mission ORSTOM au Perou. For primary bibliographic entry see Field 2E. W91-02480

PALM COMMUNITIES IN WETLAND FOREST ECOSYSTEMS OF PERUVIAN AMA-ZONIA

ZONIA.

Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Lima (Peru). Mission ORSTOM au Perou.

For primary bibliographic entry see Field 2H. W91-02482

FLOODING AND SALTWATER INTRUSION: POTENTIAL EFFECTS ON SURVIVAL AND PRODUCTIVITY OF WETLAND FORESTS ALONG THE U.S. GULF COAST. Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments. For primary bibliographic entry see Field 4C. W91-02489

### 2J. Erosion and Sedimentation

EFFECTS OF IRON CYCLING ON PB-210 DATING OF SEDIMENTS IN AN ADIRON-DACK LAKE, USA. Syracuse Univ., NY. Environmental Engineering

Program. C. P. Gubala, D. R. Engstrom, and J. R. White. Canadian Journal of Fisheries and Aquatic Sci-ences CJFSDX, Vol. 47, No. 9, p 1821-1829, Sep-tember 1990. 7 ref, 3 tab, 31 ref.

Descriptors: \*Adirondack Mountains, \*Diagenesis, \*Iron, \*Lake sediments, \*Radioactive dating, \*Sediment chemistry, \*Sediment contamination, Acid lakes, Lead radioisotopes, Model studies, Sediment analysis, Sediment-water interfaces, Sedi-

In three cores from an acidic lake in the Adiron-dack State Park of New York, iron cycling ac-counted for diagenetic enrichment of up to 14% of sediment dry mass. The accuracy of the sediment accumulation rates calculated from the constant rate of supply (CRS) model and the dating and sediment accumulation rates calculated from the sediment accumulation rates calculated from the constant initial concentration (CIC) lead-210 models were affected by post-depositional movement of iron about the sediment-water interface and through the sediment. Dating biases from iron diagenesis reached as high as 57% and biases to calculated sediment accumulation rates ranged up to approximately 15%. The difference between the iron-corrected and uncorrected dating was not much greater than the error expected from routine analytical precision. However, under circum-stances of low sediment accumulation rates and

high iron enrichment, significant deviations in dating and sediment accumulation calculations for both CRS and CIC lead-210 models may become both CRS and CIC lead-210 models may become noteworthy. The accuracy of any sediment dating technique, normalized to dry sediment mass, should be carefully evaluated in low sedimentation rate environments which show evidence of post-depositional movement of iron or other diageneti-cally active materials. (Author's abstract) W91-02071

INVESTIGATION OF THE COAGULATION MECHANISM OF THE SUSPENDED PARTIC-ULATE MATTER IN COASTAL WATERS. Patras Univ. (Greece). Physical Chemistry Lab. A. Koliadima, E. Dalas, and G. Karaiskakis. Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 1/2, p 65-73, May 1990. 6 fig. 2 tab, 7 ref. International Atomic Energy Agency Grant No. 4631/EP.

Descriptors: \*Coagulation, \*Coastal waters, \*Particle size, \*Sediment concentration, \*Suspended solids, Accumulation, Diffusion, Estuaries, Flocculation, Greece, Patras, Sedimentation

The granulometry of the suspended matter in various coastal waters collected around Patras, Greece, together with the average particle diameters, have been determined during a twelve month period by a simple, quick, inexpensive and relatively accurate photosedimentometer. The particle size distributions were found to be self-preserving and independent of time, hydrologic regime, nature and amount of particulate materials and particle mobility. The experimental results show that Brownian diffusion is the dominant factor in floculation processes in castal waters. The floculation processes in castal waters. The floculation Brownian diffusion is the dominant factor in floc-culation processes in coastal waters. The floccula-tion processes of the suspended particles taking place when river meets sea water occur because of the increase of ionic strength during mixing. As a consequence, intensive sedimentation and accum-lation of this material can occur generally in somewhat restricted zones in an estuary. (Brunone-PTT) W91-02083

STREAM SEDIMENT LOADING AND RAIN-FALL--A LOOK AT THE ISSUE. Economic Research Service, Washington, DC. For primary bibliographic entry see Field 2B. W91-02086

CONTROL OF MEIOBENTHIC ABUNDANCE BY MACROEPIFAUNA IN A SUBTIDAL MUDDY HABITAT.

Heriot-Watt Univ., Edinburgh (Scotland). Dept. of Biological Sciences.

For primary bibliographic entry see Field 2L. W91-02127

WATER DROPLET ENERGY AND SOIL AMENDMENTS: EFFECT ON INFILTRATION AND EROSION.

oil and Irrigation Research Inst., Pretoria (South Africa).

For primary bibliographic entry see Field 2G. W91-02136

POLYMER EFFECTS ON EROSION UNDER LABORATORY RAINFALL SIMULATOR CON-

Agricultural Research Organization, Bet-Dagan

Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
M. Ben-Hur, J. Letey, and I. Shainberg.
Soil Science Society of America Journal SSSJD4,
Vol. 54, No. 4, p 1092-1095, July/August 1990. 2
fig, 1 tab, 27 ref.

Descriptors: \*Erosion, \*Erosion control, \*Infiltra-tion rate, \*Rainfall impact, \*Rainfall infiltration, \*Soil amendments, \*Soil erosion, \*Soil water, Fluid drops, Particulate matter, Polymers, Simulat-ed rainfall, Soil aggregates, Surface sealing.

The effects of nonionic, anionic and two charge densities of cationic derivatized guar products on erosion and infiltration rates were investigated. The polymers were mixed with distilled water at concentrations from 0 to 20 g/cu m and applied through a rainfall simulator in the laboratory. Untreated distilled water was applied to an Artington sandy loam soil (Haplic Durixeralf) with the soil surface both unprotected and protected by a fiberglass sheet placed 0.5 cm above the soil surface. All polymer treatments were applied to the unprotected soil surface. Distilled water drop impact greatly reduced infiltration rate and increased expressly reduced infiltration rate and increased express. greatly reduced infiltration rate and increased ero-sion, compared with no impact. The anionic and nonionic polymers did not significantly affect ero-sion or infiltration rate, compared with distilled water. The cationic polymers significantly in-creased infiltration rate and erosion. The higher creased infiltration rate and erosion. The higher charge cationic polymer produced significantly higher values than the lower charge polymer at the same concentration. The distilled water treatment with impact caused severe aggregate disruption and dispersion, producing a layer of fine material at the surface that decreased infiltration rate. Apparently, the very fine particulates became imbedded in the soil matrix, which made them less susceptible to lateral transfer with flowing water. The floeoplating action of the cationic roductors. susceptible to lateral transfer with flowing water. The floculating action of the cationic polymer created larger particulates, which had very little effect in reducing infiltration rate but were more susceptible to erosion. Under the conditions of the experiment, particulates between 0.05 and 0.25 mm were most susceptible to transport by a thin sheet of flowing water. (Author's abstract) W91-02137

SLOPE, ASPECT, AND PHOSPHOGYPSUM EFFECTS ON RUNOFF AND EROSION.

Soil Erosion Research Station, Natanya (Israel). For primary bibliographic entry see Field 2E. W91-02139

HALITE DEPOSITIONAL FACIES IN A SOLAR SALT POND: A KEY TO INTERPRETING PHYSICAL ENERGY AND WATER DEPTH IN ANCIENT DEPOSITS.

ARCO Oil and Gas Co., Plano, TX.

Geology GLGYBA, Vol. 18, No. 8, p 691-694, August 1990. 7 fig, 17 ref.

Descriptors: \*Brines, \*Chemical precipitation, \*Crystallization, \*Deposition, \*Geologic history, \*Halite, \*Sedimentary structures, Aragonite, Evaporation ponds, Gypsum, Saline water, Salt pans, Salts, Sedimentary rocks.

Subaqueous deposits of aragonite, gypsum, and halite are accumulating in shallow solar salt ponds constructed in the Pekelmeer, a sea-level salina on Bonaire, Netherlands Antilles. Several halite facies Constructed in the Perceimere, a sea-ieve same on Bonaire, Netherlands Antilles. Several halite facies are deposited in the crystallizer ponds in response to differences in water depth and wave energy. Cumulate halite, which originates as floating rafts, is present only along the protected, upwind margins of ponds where low-energy conditions foster their formation and preservation. Cornet crystals with peculiar mushroom and mortarboard shaped caps precipitate in centimeter deep brine sheets within a couple of meters of the upwind or low-energy margins. Downwind from these margins, cornet and chevron halite precipitate on the pond floors in water depths ranging from a few centimeters to approximately 60 cm. Halite pisoids with radial-concentric structure are precipitated in the swash zone along downwind high-energy shorelines where they form pebbly beaches. This study or depth dependent and that some primary feasuggests that primary hante racies are energy and/ or depth dependent and that some primary fea-tures, if preserved in ancient halite deposits, can be used to infer physical energy conditions, subenvir-onments such as low to high-energy shorelines, and extremely shallow water depths in ancient evaporite basins. (Author's abstract) W91,02152

TILL GENESIS AND HYDROGEOLOGICAL PROPERTIES.

Norges Landbrukshoegskole, Aas. For primary bibliographic entry see Field 2F.

### Group 2J—Erosion and Sedimentation

ESTIMATING EROSION RISK ON FOREST LANDS USING IMPROVED METHODS OF DISCRIMINANT ANALYSIS. Pacific Southwest Forest and Range Experiment

Station, Arcata, CA. J. Lewis, and R. M. Rice.

Water Resources Research WRERAQ, Vol. 26, No. 8, p 1721-1733, August 1990. 2 fig, 6 tab, 37

Descriptors: \*Discriminant analysis, \*Erosion, \*Forest soils, \*Forest watersheds, \*Land use, \*Logging, \*Risk assessment, \*Soil erosion, Estimating equations, Forest hydrology, Model studies, Statistical analysis.

les, Statistical analysis.

Excess erosion from logging and forest roads has long been of concern to forest managers and the general public. Studies in California concluded that the key to reducing erosion from logged areas was to identify critical sites yielding at least 189 cu m/ha; this led to a definition of a critical site as any 0.81 ha acre area enclosing more than 153 cu m of erosional voids. A population of 638 timber harvest areas in northwestern California was sampled for data related to the occurrence of critical amounts of erosion. Separate analyses were done for forest roads and logged areas. Linear discriminant functions were computed in each analysis to contrast site conditions at critical plots with randomly selected controls. Bootstrapping was used extensively in the development and testing of the equations, in estimating prediction bias, and in placing confidence limits around parameters and posterior probabilities. The resulting three-variable equations had dence imits around parameters and posterior prob-abilities. The resulting three-variable equations had classification accuracy, corrected for prediction bias, of 77.7% for road plots and 69.2% for logged area plots. The variables appear to be expressing three important site conditions related to erosion three important site conditions related to erosion risk: (1) instability-promoting effects of gravity (slope steepness), (2) the convergence of subsurface water, and (3) strength of materials (parent rock strength). The use of linear discriminant functions facilitates the explicit consideration of erosion tions tacilitates the explicit consideration of erosion risk when planning land-disturbing activities. None of the steps required for the utilization of the equations are particularly difficult, but they do require a more rigorous approach to erosion risk analysis. (Tappert-PTT)

COMPARATIVE EVALUATION OF FIVE TOX-ICITY TESTS WITH SEDIMENTS FROM SAN FRANCISCO BAY AND TOMALES BAY, CALI-

National Ocean Service, Seattle, WA. Ocean As-For primary bibliographic entry see Field 5A. W91-02218 sessments Div

IMPACT OF SOIL SURFACE DETERIORA-TION ON RUNOFF PRODUCTION IN THE ARID AND SEMI-ARID ZONES OF WEST

Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Lome (Togo). Centre ORSTOM du Togo. For primary bibliographic entry see Field 4C. W91-02296

FAN-DELTA AND BRAID-DELTA SYSTEMS IN PENNSYLVANIAN SANDIA FORMATION, TAOS TROUGH, NORTHERN NEW MEXICO-DEPOSITIONAL AND TECTONIC IMPLICA-TIONS

Texas Univ. at Dallas, Richardson. Inst. for Geo-

K. Soegaard. Geological Society of America Bulletin BUGMAF, Vol. 102, No. 10, p 1325-1343, October 1990. 14 fig, 2 tab, 79 ref.

Descriptors: \*Alluvial channels, \*Channel morphology, \*Deltas, \*Geology, \*Geomorphology, \*Paleohydrology, \*Sedimentary basins, \*Tectonics, Alluvial deposits, Alluvial fans, New Mexico, Pennsylvanian Sandia Formation, Sandstones, Sedimentation rates, Taos Trough.

Fan-delta and braid-delta deposits were distinguished in the Pennsylvanian Sandia Formation,

Taos Trough, New Mexico. Fan deltas were delaos Irough, New Mexico. Fan deitas were de-posited in close proximity to the active western boundary fault of the Taos Trough and occur as coarse-grained aggradational sequences. Alluvial processes in fan-delta complexes were character-ized by unrestricted sheetflood and ephemeral stream flow deposition. Subaqueously deposited, fan-delta conglomerates and sandstones arranged in lenticular units encased by basinal mudstones were emplaced by a variety of high density and dilute gravity flow processes. Braid-delta complexes were characterized by channelized alluvial deposition in which discharge was variable, but perennial. Perennial discharge in the braid deltas was in response to expansion of the drainage area in the Taos Trough hinterland through time. This resultand strough minertand through time. This results and enabled basinward extension of the alluvial plain by braid-delta progradation. It is concluded that fan deltas are associated with steep basin margins in which overall subsidence rates exceed sedigins in which overall subsidence rates exceed sedi-mentation rates. Braid deltas are related to low gradient basin margins along which sedimentation rates are greater than subsidence rates. Distribution of fan-delta and braid-delta complexes in the Sandia Formation is dictated by tectonic load-induced subsidence in the Taos Trough and may be used as a guide for resolving evolutionary histo-ry of other types of active sedimentary basins. (Author's abstract) W91-02519

EFFECTS OF GLACIAL SURGING ON SEDI-MENTATION IN A MODERN ICE-CONTACT

LAKE, ALASKA.
Illinois Univ. at Chicago Circle. Dept. of Geologi-N D Smith

N. D. Smith. Geological Society of America Bulletin BUGMAF, Vol. 102, No. 10, p 1393-1403, October 1990. 13 fig, 1 tab, 42 ref. NSF Grants DPP84-20807 and 86-18789.

Descriptors: \*Glacial lakes, \*Glacier surges, \*Glaciers, \*Glacionydrology, \*Lake sediments, \*Sedimentation, Alaska, Carroll Glacier, Erosion, Glacier Bay, Lake basins, Sediment concentration, Sediment load, Sedimentation rates, Suspended

In June 1987, Carroll Glacier (Glacier Bay, south-east Alaska) began to surge southeastward toward Wachusett Inlet. Between 9 June and 1 July 1987, the terminus advanced with a mean velocity of 29 m/day, slowing afterward but attaining a net dis-placement of >1 km by July 1988. A proglacial lake lay directly in the path of the surge and became partly overridden, with only 25% of its former basin remaining exposed after 1 yr. The effects of the ice advance on the lake were pro-found. Early in the surge, lake water samples attound. Early in the surge, take water samples attained suspended sediment concentrations exceeding 9 g/L well above bottom. Extremely rapid sedimentation, locally attaining 8 m in 36 days, produced nearly uniform depths of 8-9.5 m by August 1987. Sediment deposited during the surge was extremely soft and underconsolidated contract of security of the service of the security of the posed of massive to irregularly layered muddy silt produced by disruptions of the lake floor and by remobilization of lake bottom sediment by sediremonization of lake bottom sediment by secure ment gravity flows. A prominent push moraine, developed from a low ridge initiated by glacial loading, formed where the glacier overrode sandy substrate, but no similar feature was observed in substrate, but no similar leature was observed in the muddy lake floor. By July 1988, the surge had greatly diminished, and the remaining lake basin was slowly uplifted by displacement from the weight of the ice. By the end of August 1988, most of the lake floor was completely exposed and undergoing erosion by meltwater channels, causing abnormally high suspended sediment loads at the outlet compared to the previous year when the lake was an effective sediment sink. (Author's abstract) W91-02520

CONTROLLING MECHANISM OF LOCAL SCOURING.

SCOURING.
Royal Inst. of Tech., Stockholm (Sweden). Dept.
of Hydraulics Engineering. B. Dargahi.

Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 10, p 1197-1214, October

Descriptors: \*Channel erosion, \*Erosion, \*Flow around objects, \*Scour, \*Sediment transport, \*Vortices, Boundary layers, Clear water, Flow, Mathematical analysis, Mathematical equations,

Experimental study of clear water scouring around a circular cylinder showed that the scour mechanism is coupled to the three-dimensional separation of the upstream boundary layer and the periodic vortex shedding in the wake of the cylinder. The first scour appears in the wake of the cylinder. The main scouring in the upstream region is a system of horseshoe vortices. The vortices have a periodical character that causes a triple-scour effect to develop in the upstream region. During scouring, the number and periods of horseshoe vortex shedding undergo no appreciable change. Despite the clear water stage, the transport phenomenon is periodical. Transport of sediment takes place through turbulent scales of comparable size to macrolength scales. The size of the horseshoe vortices is representative for the macroscale. Wake scouring is caused by the primary wake vortices and the representative for the macroscale. Wake scouring is caused by the primary wake vortices and the accelerated side flow. The process is characterized by a strong periodical transport and the formation of ripples. The periodicity is controlled by the shedding frequency of the wake vortices. Collars attached to the cylinder cannot prevent the formation of the vortices. (Author's abstract)

FIELD VERIFICATION OF 2-D AND 3-D SUS-PENDED-SEDIMENT MODELS.

PENDELP-SEDIMENT MODELS.
Waterloopkundig Lab. te Delft (Netherlands).
L. C. van Rijn, H. van Rossum, and P. Termes.
Journal of Hydraulic Engineering (ASCE)
JHENDS, Vol. 116, No. 10, p 1270-1288, October
1990. 11 fig, 1 tab, 13 ref, append.

Descriptors: \*Model studies, \*Model testing, \*Sediment concentration, \*Sediment transport, \*Suspended sediments, Eastern Scheldt Estuary, Estuarine sediments, Flow velocity, The Nether-

A tidal channel in the Eastern Scheldt estuary in the Netherlands was closed by pumping a sandwater mixture into the closure gap. During the closure, field measurements of flow velocities and sand concentrations were carried out. Based on the results of the field measurements, computations with two discussions and the said the said and the said the said and the said with two-dimensional and three-dimensional sedi-ment transport models were performed. The two-dimensional computations showed that the depth-integrated transport rates could be reasonably preintegrated transport rates could be reasonably pre-dicted (within a factor of 2) in case of diverging flow. However, less satisfactory results were ob-tained for converging flow. The three-dimensional computations showed quite good agreement be-tween measured and predicted flow velocities, sediment concentrations, and transport rates, both for flood and ebb flow. A sensitivity analysis with respect to the time-dependent concentration term, the shape of the velocity profiles, the turbulent mixing coefficients, and the bed material gradation indicated no significant influence of these param-eters. The main reason for the difference between measured and predicted results was caused by the formula modeling the sediment pickup rate (at the bottom). (Author's abstract)

MISSISSIPPI RIVER-GULF OUTLET, LOUISI-ANA: FIELD DATA REPORT.

Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab. For primary bibliographic entry see Field 2E. W91-02604

STUDY OF EMBANKMENT PERFORMANCE DURING OVERTOPPING AND THROUGH-FLOW. REPORT 2: HYDRAULIC STUDY AND MODELING OF MODELS. Colorado Univ., Boulder.

### Erosion and Sedimentation—Group 2J

For primary bibliographic entry see Field 8B. W91-02608

STUDY OF EMBANKMENT PERFORMANCE DURING OVERTOPPING AND THROUGH-FLOW. REPORT 3: MODEL-PROTOTYPE COMPARISON STUDIES. Colorado Univ., Boulder. For primary bibliographic entry see Field 8B. W91-02610

SEDIMENT-WATER-EQUILIBRIA: THE SORPTION OF VOLATILE CHLORINATED HYDROCARBONS AND DICHLORO BENTZENES BY SEDIMENTS. (SEDIMENT-WASSER-GLEICHGEWICHTE: VERHALTEN FLUCHTIGER CHLORKOHLENWASSER-STOFFE UND DER DICHLORBENZOLE AN GEWASSERSEDIMENTEN).

Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik. For primary bibliographic entry see Field 5B. W91-02668

GEOSTATIC COMPACTION BEHAVIOUR OF KAOLIN MUDS-EFFECTS OF DIFFERENT SAMPLE PREPARATION PROCEDURES, Kiel Univ. (Germany, F.R.). Geologisch-Palaeontologisches Inst. und Museum.
V. Feeser, and H. Knoke.
Applied Clay Science ACLSER, Vol. 5, No. 1, p 67-83, May 1990. 8 fig, 3 tab, 18 ref.

Descriptors: \*Clays, \*Consolidation sedimentation, \*Laboratory methods, \*Sample preparation, \*Sedimentology, \*Soil compaction, \*Soil mechanics, Boundary conditions, Fabrics, Mud-water interfaces, Slurries.

Experimental laboratory studies of initial compaction mechanisms in clay muds may be performed either by artificially sedimented samples or by simple stirred pastes (without consideration as to application of the results for natural processes). Little intensive research has been performed on the application of the results for natural processes). Little intensive research has been performed on the differences in the two preparation procedures. Homogeneous kaolin was geostatically consolidated in the laboratory. Samples were prepared by mixture of a clay-water slurry and sedimentation with a clay-water suspension. The stress-strain behavior was analyzed by rigid analytical and experimental boundary conditions. It was found that the method of sample preparation does not qualitatively affect the initial compaction behavior of clay muds. The correlations between compression and swelling parameters indicate that all the samples, regardless of the method of preparation and the resulting differences in fabric, show no significant differences in elastic potential. Less deformation work needs to be performed to consolidate sedimented samples than is the case with stirred samples. With regard to reproducibility, significance, and application of correlations between physicochemical and mechanical behavior, normal soil mechanical standards are not sufficient to reveal all the mechanisms of clay mud compaction. Stirred samples can be used for basic research in studies of material laws without affecting qualitatively the degree of prediction. useu for oasic research in studies of material laws without affecting qualitatively the degree of pre-diction. Sedimented samples adapted to the respec-tive environment must be employed if a direct application to natural conditions is desired. These ults are in contrast to previous findings. (Fish-PTT W91-02802

LARGE-SCALE FLOODPLAIN MODELLING. Hydrologic Engineering Center, Davis, CA. For primary bibliographic entry see Field 2E. W91-02808

HYDROLOGICAL RESPONSE OF SOIL SUR-FACES TO RAINFALL AS AFFECTED BY COVER AND POSITION OF ROCK FRAG-MENTS IN THE TOP LAYER. Katholieke Univ. Leuven (Belgium). Lab. voor Experimentele Geomorfologie. J. Poesen, F. Ingelmo-Sanchez, and H. Mucher. Earth Surface Processes and Landforms ESPLDB,

Vol. 15, No. 7, p 653-671, November 1990. 12 fig, 2 tab, 53 ref. Commission of the European Communities D. G. XII contract no. EV4V-0112-C.

Descriptors: \*Infiltration, \*Rainfall-runoff relationships, \*Soil erosion, \*Soil properties, \*Soil surfaces, \*Topsoil, Hydraulic conductivity, Hydrologic models, Model studies, Morphology, Overland flow, Runoff coefficient, Runoff volume, Saturated soils, Surface sealing.

Rainfall experiments have been conducted in the laboratory in order to assess the hydrological response of topsoils very susceptible to surface sealing and containing rock fragments in different positions with respect to the soil surface. For a given cover level, rock fragment position in the topsoil has an ambivalent effect on water intake and runoff generation. Compared to a bare soil surface rock fragments increase water intake rates as well as iragments increase water intake rates as well as time of runoff concentration and decrease runoff volume if they rest on the soil surface. For the same cover level, rock fragments reduce infiltration rate and enhance runoff generation if they are well-embedded in the top layer. The effects of rock fragment position on infiltration rate and runoff generation are proportional to cover per-centage. Micromorphological analysis and meas-urements of the saturated hydraulic conductivity urements of the saturated hydraulic conductivity of bare topsoils and of the top layer underneath rock fragments resting on the soil surface reveal significant differences; runoff generated as rock flow or as Horton overland flow can (partly) infiltrate into the unsealed soil surface under the rock fragments, provided that they are not completely embedded in the top layer. Hence, rock fragment position, beside other rock fragment properties, should be taken into account when assessing the hydrological response of soils susceptible to surface sealing and containing rock fragments in their surface layers. A simple model, based on the proportions of bare soil surface, soil surface occupied by embedded rock fragments; and soil surface covered with rock fragments resting on the soil surered with rock fragments resting on the soil sur-face, describes the runoff coefficient data relatively well. (Author's abstract) W91-02812

NOURISHMENT OF PERCHED SAND DUNES AND THE ISSUE OF EROSION CONTROL IN THE GREAT LAKES.

Michigan Univ.-Flint. Dept. of Resource Science. W. M. Marsh.

Environmental Geology and Water Sciences EGWSEI, Vol. 16, No. 2, p 155-164, 1990. 6 fig, 1

Descriptors: \*Dunes, \*Erosion control, \*Great Lakes, \*Lake shores, \*Wind erosion, Aeolian de-posits, Lake management, Sand, Vegetation ef-fects, Water level fluctuations.

Although limited in coverage, perched sand dunes situated on high coastal bluffs are considered the most prized of Great Lakes dunes. Grand Sable Dunes on Lake Superior and Sleeping Bear Dunes on Lake Michigan are featured attractions of national lakeshores under National Park Service management. The source of sand for perched dunes is the high bluff along their lakeward edge. As onshore wind croses the bluff, flow is accelerated upslope, resulting in greatly elevated levels of wind stress over the slope brow. On barren, sandy bluffs, wind erosion is concentrated in the brow zone, and for the Grand Sable Bluff, it averaged I cu m/yr per linear meter along the highest sections cu m/yr per linear meter along the highest sections for the period 1973-1983. This mechanism accounts for the period 1973-1983. This mechanism accounts for about 6,500 cu m of sand nourishment to the dunefield annually and clearly has been the predominant mechanism for the long-term development of the dunefield. However, wind erosion and dune nourishment are possible only where the bluff is denuded of plant cover by mass movements and related processes induced by wave erosion. In the Great Lakes, wave erosion and bluff retreat vary with lake levels; the nourishment of perched dunes is favored by high levels. Lake levels have been relatively high for the past 50 years, and shore erosion has become a major environmental issue leading property owners and politicians to support lake-level regulation. Trimming high water levels could reduce geomorphic activity on high bluffs

and affect dune nourishment rates. Locally, nour-ishment also may be influenced by sediment accu-mulation associated with harbor protection facili-ties and by planting programs aimed at stabilizing dunes. (Author's abstract)

SPATIAL UNIFORMITY OF POWER AND THE ALTITUDINAL GEOMETRY OF RIVER NETWORKS.

Massachusetts Inst. of Tech., Cambridge, Ralph M. Parsons Lab

For primary bibliographic entry see Field 2E. W91-02860

WIDTH AND DEPTH OF SELF-FORMED STRAIGHT GRAVEL RIVERS WITH BANK VEGETATION.

Tokyo Inst. of Tech. (Japan). Dept. of Civil Engi-

neering.
For primary bibliographic entry see Field 2E. W91-02865

METAL-ORGANIC ASSOCIATIONS IN SEDI-MENTS--I. COMPARISON OF UNPOLLUTED RECENT AND ANCIENT SEDIMENTS AND SEDIMENTS AFFECTED BY ANTHROPOGENIC POLLUTION.

Munich Univ. (Germany, F.R.). Mineralogisch-Petrographisches Inst.

For primary bibliographic entry see Field 5B. W91-02891

METAL-ORGANIC ASSOCIATIONS IN SEDI-MENTS-II. ALGAL MATS IN CONTACT WITH GEOTHERMAL WATERS.

Munich Univ. (Germany, F.R.). Mineralogisch-Petrographisches Inst. A. V. Hirner, R. E. Krupp, A. R. Gainsford, and

A. V. Hill H. Staerk.

Applied Geochemistry APPGEY, Vol. 5, No. 4, p 507-513, July/August 1990. 1 fig, 3 tab, 40 ref.

Descriptors: "Algae, "Chemical interactions, "Geothermal water, "Metals, "Organic matter, "Sediments, "Water chemistry, Arsenic, Cesium, Iron, Kerogen, Lanthanum, New Zealand, Phosphorus, Tin, Trace elements, Zinc.

Organic matter from living algal mats and their decay products from mud pools of the geothermal areas at Rotokawa and Waimangu, New Zealand, was separated into solvent-extractable and protowas separated into solvent-extractable and proto-kerogen fraction. Fourteen elements were deter-mined in the bulk samples and the solvent extracta-ble fractions by optical emission spectroscopy, and 15 elements (including some rare earth elements) in the protokerogen concentrates by instrumental neutron activation analysis. Many elements were strongly enriched in the organic fractions as comstrongly entrened in the organic tractions as com-pared to the bulk sample: concentrations in the extracts are of the order of grams per kg for P, Zn and Sb, and 10g/kg for As; those in protokerogens are 10 g/kg for Fe and Sb, and 100 mg/kg for La and Ce. The results demonstrate that in contact with metal-rich geothermal waters, biogenic matewith measurics geotherman waters, origine material is able to incorporate high amounts of metals into the organic matrix. While inorganic contributions to the solvent-extractable fractions are shown to be minimal, the presence of inorganic microinclusions in protokerogen concentrates cannot be excluded. (See also W91-02891) (Author's abstract) W91-02892

CORRELATION OF EROSION MEASURE-MENTS AND SOIL CAESIUM-137 CONTENT. Soil Conservation Service, Gunnedah (Australia). G. L. Elliott, B. L. Campbell, and R. J. Loughran. International Journal of Radiation Applications & Instrumentation. A, Appl. Radiation & Isotopes ARISEF, Vol. 41, No. 8, p 713-717, 1990. 2 fig, 1 tab, 43 ref.

Descriptors: \*Cesium radioisotopes, \*Erosion, \*Land use, \*Regression analysis, \*Soil erosion, \*Tracers, Australia, Cultivated lands, Data inter-

### Field 2-WATER CYCLE

### Group 2J-Erosian and Sedimentation

pretation, Land management, Rills, Sheet erosion, Soil management.

Progress in erosion research has been substantially restrained because there is no simple technique for the estimation of long-term soil loss rates. A tech-nique has been developed that uses a calibration between measured soil loss from small plots with measured soil CS-137 content (expressed as a per-centage loss relative to the Cs-137 content of a centage loss relative to the Cs-137 content of a local stable reference soil). Sites of soil loss meas-urement throughout Australia were sampled by coring to determine their relative Cs-137 content. Measurements made on erosion/runoff plots are confined to the effects of shallow, ephemeral rills and sheet erosion by water. Plotting the average soil loss results against residual cesium content relative to a local, stable reference site indicated that their relationship was exprengial Soil loss that their relationship was exponential. Soil loss data were therefore log-transformed and a regular data were therefore log-transformed and a regular regression analysis was performed on the data. Precision was considerably improved by partition-ing the data into sets for cultivated soils and pas-ture land. These regressions were highly signifi-cant for pasture plot results and for cultivated sites. The measured soil losses form erosion/runoff plots are real data which may be extrapolated to other areas if an acceptable correlation is found with an easily measured soil attribute. The 95% confidence limits on the regressions reflect real field variabililimits on the regressions reflect real field variability. Comparisons of prediction of soil erosion by the regression method and by the proportional method indicate that estimates by the proportional method are approximately 10 times greater. The regression represents a simple and rapid tool for the estimation of net soil loss from sites which have a uniform and continuous history of land-use. (Fish-PTT) W91-02913

MODELING CHANNEL BED TRANSIENTS USING EXPLICIT F-D SCHEMES.

Ottawa Univ. (Ontario). Dept. of Civil Engineer-

For primary bibliographic entry see Field 2E. W91-02918

TURBULENT SHEAR STRESS IN HETEROGE-NEOUS SEDIMENT-LADEN FLOWS.

Korea Inst. of Construction Technology, Seoul. H. Woo, and P. Y. Julien.

Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 11, p 1416-1421, November 1990. 1 fig, 1 tab, 6 ref, append.

Descriptors: \*Alluvial channels, \*River mechanics, \*Sediment transport, \*Shear stress, \*Turbulent flow, Fall velocity, Open-channel flow, Particle size, Sediment discharge, Sedimentation rates, Set-

Current knowledge of the mechanics of alluvial channels depends very largely on calculations of turbulent shear stress; typical examples are the beginning of motion of sediment particles and sediment transport in alluvial channels. Comparatively little is known about shear stresses in sediment-laden flows. The analysis of turbulent shear stress for steady-uniform flows carrying heterogeneous sediment mixtures provides additional insight on the role played by sediment size gradation and fall velocity by size fraction. A derivation has been the role played by sectiment size gradation and tail velocity by size fraction. A derivation has been developed of turbulent stress in heterogeneous sediment-laden flows, and considers the steady and uniform motion of this flow type in an open channel. These relationships demonstrate that the average velocity in the vertical direction is not zero but proportional to the fall velocity of sediment particles and the conservation of each size for exist. proportional to the fall velocity of sediment parti-cles and the concentration of each size fraction. The derivation shows that turbulent shear stress in sediment-laden flows is similar to that of the water flow except that the fluid mass density is replaced with the density of the water sediment mixture. It was concluded that the sediment size distribution and the fall velocity of sediment particles do not affect turbulent shear stress of heterogeneous sedi-ment mixtures under steady-uniform flow condi-tions (Author's abstract) tions. (Author's abstract) W91-02923

FIRST STEP AWAY FROM LACEY'S REGIME For primary bibliographic entry see Field 8B. W91-02924

BED CONFIGURATIONS IN STEADY UNIDIR-ECTIONAL WATER FLOWS: PART I. SCALE MODEL STUDY USING FINE SANDS. Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences. For primary bibliographic entry see Field 2E. W91-02925

BED CONFIGURATIONS IN STEADY UNIDIR-ECTIONAL WATER FLOWS: PART II. SYN-THESIS OF FLUME DATA.

Massachusetts Inst. of Tech., Cambridge. Dept. of Massachusetts Inst. of Tech., Cambridge. De Earth, Atmospheric and Planetary Sciences. For primary bibliographic entry see Field 2E. W91-02926

BED CONFIGURATIONS IN STEADY UNIDIR-ECTIONAL WATER FLOWS: PART III. EF-FECTS OF TEMPERATURE AND GRAVITY. Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences. For primary bibliographic entry see Field 2E. W91-02927

FLUME EXPERIMENTS ON THE TRANS-PORT OF HEAVY MINERALS IN GRAVEL-BED STREAMS.

Massachusetts Inst. of Tech., Cambridge. Dept. of Earth and Planetary Sciences.
R. A. Kuhnle, and J. B. Southard.

R. A. Kuhnle, and J. B. Southard. Journal of Sedimentary Petrology JSEPAK, Vol. 60, No. 5, p 687-696, September 1990. 9 fig. 2 tab. 40 ref. Anglovaal Mining Company, the MIT De-partment of Earth, Atmospheric, and Planetary Sciences, and the National Science Foundation Grant EAR 84-15466.

Descriptors: \*Flow models, \*Flumes, \*Hydraulic models, \*Minerals, \*Sediment transport, Channel flow, Degradation, Erosion, Gravel, Sedimentation, Slopes, Stream discharge, Streamflow data.

Heavy-mineral transport and deposition by shallow unidirectional flows in a gravel-bed channel were unidirectional flows in a gravel-bed channel were studied in a water-recirculating sediment-feed flume. The heavy minerals became concentrated into a thin layer (the heavy infralayer) composed of nearly 100% heavy minerals lying beneath a thin surficial layer of low-density sediment (the light supralayer). Heavy minerals were not transported past a given location on the bed until the heavy infralayer was fully developed there. Heavy minerals were transported on the upper surface of the heavy infralayer only when local and temporary erosion of the light supralayer exposed the heavy infralayer. In two runs, one with sediment feed and one without, overall degradation of the bed was forced by slow lowering of a tailgate at bed was forced by slow lowering of a tailgate at the downstream end of the channel. In the sediment-feed run a downstream-prograding heavy in-fralayer formed as in the nondegrading runs. In the run without feed, the surficial heavy-mineral con-centration increased gradually at all points along the channel to the end of the run. These results the channel to the end of the run. These results indicate that ultimately the surficial heavy-mineral concentration would reach a steady state and the bed slope would change until the flow can transport all of the heavy-mineral sediment supplied by local exhumation. A too-small initial slope caused overall bed aggradation in the early parts of two runs. Heavy minerals in the feed sediment were transported only a short distance downstream to form a zone of higher but downstream-decreasing heavy mineral concentration extending vertically heavy mineral concentration extending vertically through the deposit. It is hypothesized that the downstream length of this zone would increase as the heavy-mineral feed rate increases relative to the bed aggradation rate. (Author's abstract) W91-02928

GLACIOMARINE SEDIMENTATION IN DIS-RAELI FJIORD, HIGH ARCTIC CANADA. Alberta Univ., Edmonton. Dept. of Geography.

D. S. Lemmen. D. S. Lemmen.

Marine Geology MAGEA6, Vol. 94, No. 1/2, p 922, July 1990. 8 fig. 1 tab, 69 ref. Natural Sciences
and Engineering Research Council of Canada
grant A6680; Boreal Institute for Northern Studies,
University of Alberta grant.

Descriptors: \*Arctic zone, \*Canada, \*Fjords, \*Glacial sediments, \*Glaciohydrology, \*Glacionagy, \*Sediment transport, \*Sedimentation, Climatic changes, Deposition, Ellesmere Island, Geologic history, Glacial drift, Glaciation, Glaciers, Holocene Epoch, Sea ice, Sedimentation rates, Settling velocity, Snowmelt.

Disraeli Fjiord, in High Arctic Canada, represents a glaciomarine environment unique to the north coast of Ellesmere Island, featuring floating glacier a glaciomarine environment unique to the north coast of Ellesmere Island, featuring floating glacier tongues, multi-year landfast sea ice and a strongly stratified water body which results from enclosure of the fiord by Ward Hunt Ice Shelf. It is a very low energy depositional environment, even at sites proximal to glaciers. Sediment enters the fiord by interflow and is deposited through suspension settling. Ice rafting is precluded by the year-round sea ice cover. Sedimentation rates in the inner flord since about 7000 years B.P. are estimated to be 5-10 cm/ka, a reflection of the limited sediment influx from cold-based glaciers which contact the flord. Changes in sediment structure through the Holocene reflect changes in the rate and process of sediment input as well as changes in flord circulation, all of which relate to regional climate. During deglaciation (early Holocene) sedimentation rates were orders of magnitude greater than at present. Subglacial meltwater was the dominant source of inflow, with sediment transported in turbid plumes as overflow or interflow and deposited through suspension settling. This is supportive of other studies indicating that a pronounced climatic amelioration led to warm-based glaciers at this time. (Author's abstract) W91-02929

INTEGRATED CHEMICAL AND BIOLOGICAL STUDY OF THE BIOAVAILABILITY OF METALS IN SEDIMENTS FROM TWO CON TAMINATED HARBOURS IN NEW BRUNS-WICK, CANADA

Environmental Protection Service, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 5B.
W91-02931

### 2K. Chemical Processes

HALITE DEPOSITIONAL FACIES IN A SOLAR SALT POND: A KEY TO INTERPRETING PHYSICAL ENERGY AND WATER DEPTH IN ANCIENT DEPOSITS. ARCO Oil and Gas Co., Plano, TX For primary bibliographic entry see Field 2J. W91-02152

PRECONCENTRATION OF COPPER ON ALGAE AND DETERMINATION BY SLURRY GRAPHITE FURNACE ATOMIC ABSORPTION SPECTROMETRY.

Texas Univ. at Austin. Dept. of Chemistry and

Biochemistry.
For primary bibliographic entry see Field 5A.
W91-02191

ENZYME-LINKED IMMUNOSORBENT ASSAY COMPARED WITH GAS CHROMA-TOGRAPHY/MASS SPECTROMETRY FOR THE DETERMINATION OF TRIAZINE HER-BICIDES IN WATER.
Geological Survey, Lawrence, KS. Water Re-

For primary bibliographic entry see Field 5A. W91-02192

SLOWLY REVERSIBLE SORPTION OF ALI-PHATIC HALOCARBONS IN SOILS, I. FOR-MATION OF RESIDUAL FRACTIONS, Connecticut Agricultural Experiment Station,

### Chemical Processes—Group 2K

New Haven. Dept. of Soil and Water. For primary bibliographic entry see Field 5B. W91-02209

COMPARISON OF QUARTER-HOURLY ON-LINE DYNAMIC HEADSPACE ANALYSIS TO PURGE-AND-TRAP ANALYSIS OF VARYING VOLATILE ORGANIC COMPOUNDS IN DRINKING WATER SOURCES. Dread Univ., Philadelphia, PA. Dept. of Chemis-

try.
For primary bibliographic entry see Field 5A.
W91-02219

WATER-QUALITY CHARACTERISTICS OF THE COLUMBIA PLATEAU REGIONAL AQ-UIFER SYSTEM IN PARTS OF WASHINGTON, OREGON, AND IDAHO.
Geological Survey, Tacoma, WA. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-02223

GEOCHEMISTRY OF THE STRATIFIED-DRIFT AQUIFER IN KILLBUCK CREEK VALLEY WEST OF WOOSTER, OHIO. Geological Survey, Columbus, OH. Water Re-sources Div. For primary bibliographic entry see Field 2F. W91-02286

GROUNDWATER QUALITY IN RURAL AREAS IN WESTERN AFRICA. International Bank for Reconstruction and Development, Abidjan (Ivory Coast). Regional Water and Sanitation Group. For primary bibliographic entry see Field 2F. W91-02336

CORROSIVITY PROBLEMS IN RURAL WATER SUPPLY PROJECTS IN SAHELIAN AREAS OF WEST AFRICA.
C.M. Consulting and Management, Rome (Italy). For primary bibliographic entry see Field 2F. W91-02337

IMPACT OF HANDPUMP CORROSION ON WATER QUALITY.

WALER QUALITY.
International Bank for Reconstruction and Development, Abidjan (Ivory Coast). Regional Water and Sanitation Group.
For primary bibliographic entry see Field 5F.
W91-02338

SOLUTION OF DISSEMINATED CALCITE IN QUARTZ VEINS OF BIRRIMIEN SCHISTS IN BURKINA FASO AS A KEY TO A POSSIBLE AQUIFER MODEL.
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
For primary bibliographic entry see Field 2F. W91-02346

PELAGIC CALCITE PRECIPITATION AND TROPHIC STATE OF HARDWATER LAKES. Akademie der Wissenschaften der DDR, Betill Zentralinstitut fuer Mikrobiologie und Experimen-Zentrainstitut ther Mikrobiologie and Experi telle Therapie. For primary bibliographic entry see Field 2H. W91-02377

MEASUREMENT AND CALCULATION OF DINITROGEN FIXATION IN WATER BODIES, Humboldt-Univ. zu Berlin (German D.R.). Sektion Biologie.

G. Dudel, M. Schlangstedt, A. Heder, and J. G. Kohl.

Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 723-731, 1990. 4 fig, 2 tab, 28 ref.

Descriptors: \*Analytical techniques, \*Limnology, \*Nitrogen cycle, \*Nitrogen fixation, \*Stagnant water, \*Water analysis, Acetylene reduction, Enzymes, Hydrogen, Light effects, Nitrogenase.

An optimal test system for the use of the acetylene reduction technique to determine the nitrogenase activity and the calculation of atmospheric nitrogen input to stagnant water bodies requires rapid measurements over a small range of substrate concentrations, especially in the case of a narrow centrations, especially in the case of a narrow vapor-aqueous phase relation. An equation is presented for the calculation of real optimal acetylene concentrations in the aqueous phase at different aqueous-vapor phase relations and variable injection volumes. Comparison of the acetylene reduction with the real dinitrogen fixation showed that the commonly assumed conversion factor of 3 is untenable. In the course of a simulated light-dark cycle a substantial dark acetylene reduction was observed. Belativiely high rester were researched. cycle a substantial dark acetylene reduction was observed. Relatively high rates were measurable immediately after the beginning of the light period. This discrepancy of acetylene and dinitrogen reduction rates can be explained in the context of the hydrogenase function of nitrogenase. Steady state uptake kinetics show that with substrate-saturated N2 assimilation one mole of H2 is produced per prole of fixed N2 Therefore the assumed theoretic. mole of fixed N2. Therefore the assumed theoreti-cal factor must not be lower than 4. The relatively cal factor must not be lower than 4. The relatively high conversion factors could be explained by using acetylene as substrate; the whole electron flow capacity of the nitrogenase complex is used. Under this condition H2 production may be com-Under this condution H2 production may be completely inhibited. Therefore a considerable overestimation of the dinitrogen input calculated from acetylene reduction rates occurs if a conversion factor is used without regarding its light dependence. (Author's abstract)
W91-02378

ORGANIC SOLVENT-SOLUBLE CONTENTS OF NICKEL AND COBALT IN SOME ALGAE. Mainz Univ. (Germany, F.R.). Inst. fuer Anorgan-ische Chemie und Analytische Chemie. For primary bibliographic entry see Field 5B. W91-02401

RELATIONSHIP BETWEEN MIXING PROC-ESS AND CONCENTRATIONS OF MAJOR IONS IN SPANISH MEDITERRANEAN BRACKISH WATERS.

Barcelona Univ. (Spain). Dept. de Ecologia.

P. Lopez.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 2, p 231-241, 1990. 3 fig, 3 tab, 28 ref.

Descriptors: \*Brackish water, \*Coastal waters, \*Saline-freshwater interfaces, \*Water chemistry, Calcium, Carbonates, Chlorides, Gypsum, Ions, Magnesium, Mediterranean Sea, Potassium, Seas, Sodium, Sulfates.

The chemical composition of 17 coastal systems located in the Mediterranean Spanish basin was studied in order to identify the main processes controlling the concentrations of major ions (HCO3(-), Cl(-), SO4(2-), Ca(2+), Mg(2+), Na(+), K(+)) in the brackish waters of the region. Theoretical concentrations of ions were calculated examples a cincle by the process between seawners. assuming a single mixing process between seawater and mineralized freshwaters. In the El Hondo area, assuming a single mixing process between seawater and mineralized freshwaters. In the El Hondo area, seawater and freshwater inputs entered the lagoons partially by underground inflow, leaching areas with gypsum deposits. Both sea and freshwaters were undersaturated with respect to gypsum, so redissolution took place, increasing the concentrations of Ca(2+) and SO2(2-). A good correlation between percentage of seawater and concentrations of Na(+), SO2(2-) and Mg(2+) was found at El Hondo. Ca(2+) concentration was more independent of seawater and the mixing process due to the participation of Ca(2+) in chemical precesses. On the Valencia coast, the systems studied always received a very low percentage of seawater, so this parameter was not correlated to observed ionic concentrations. Highly significant coefficients found between observed and predicted values for Na(+), SO2(2-) and Mg(2+) would be due to freshwater influence. As in El Hondo area, reaction between seawater and fluvial clays involved decrease of K(+) concentration, which in this area was not compensated by marine contribution. In the Castellon region, there were no perennial decrease of K(+) concentration, wincen in fins area was not compensated by marine contribution. In the Castellon region, there were no perennial rivers entering the lagoons and inflow was by groundwater upwelling, seawater filtration through sand barriers and ephemeral runoff. The

substrate was mainly calcareous, so redissolution of calcite took place causing an increase in HCO3(-) and Ca(2+) inputs. In the regions studied, Na(+) was the only ion that could be considered dependwas the only ion that could be considered dependent on the proportion of seawater alone. SO4(2-), Mg(2+), and K(+) were also greatly influenced by marine inputs, but their concentrations were modified by geological, hydrological and biological factors. (Mertz-PTT) W91-02456

HYDROGEOCHEMICAL AND ISOTOPICAL INVESTIGATIONS OF GROUND AND SURFACEWATERS AT THE SOUTHWEST EDGE OF THE HARZMOUNTAINS DURING AN ARTIFICIAL INDUCED HIGH WATER (HYDROGEOCHEMISCHE UND ISOTOPENCHEMISCHE UNTERSUCHUNGEN AN GRUND UND OBERFLACHENWASSERN AM SUDWESTRAND DES HARZES WAHREND EINES KUNSTLICH INDUZIERTEN HOCHWASSERS

WASSERS).
Goettingen Univ. (Germany, F.R.). Sedimentpetrographisches Inst.
M. E. Bottcher, and I. Rienacker.
Zeitschrift fuer Wasser - und Abwasser Forschung
ZWABAQ, Vol. 23, No. 4, p 136-140, August
1990. 5 fig, 2 tab, 21 ref. English summary.

Descriptors: \*Acid rain, \*Artificial recharge, \*Geochemistry, \*Path of pollutants, \*Stable iso-topes, \*Water chemistry, Germany, \*Surface groundwater relations, Springs, Karst hydrology, Sulfur radioisotopes, Oder River, Basin of Pohlde, Rhume River, Harz Mountains.

An investigation was conducted during a dry period of weather in August 1988, the influence of artificially high water at the Oder River on the hydrochemical and isotopic composition of karstwaters from the 'Basin of Pohlde', and the karstwaters from the Basin of Pohlde', and the springs of the Rhume River. For the first time, the separate effects of the infiltrating Oder River water on the discharge and hydrochemical composition of the springs were clearly demonstrated. In re-sponse to the high water, the well water BLS showed a complex subsurface mixing behavior. The delta S-34 values of the dissolved sulfate indicated 18 to 36 mg/L of anthropogenic sulfate. (Author's abstract)
W91-02545

TYPE OF SUSPENDED CLAY INFLUENCES LAKE PRODUCTIVITY AND PHYTOPLANK-TON COMMUNITY RESPONSE TO PHOS-PHORUS LOADING

Hampton Univ., VA. Center for Marine and Envi-ronmental Studies. For primary bibliographic entry see Field 2H. W91-02586

QUANTITATIVE ASSESSMENT OF THE SOURCES AND GENERAL DYNAMICS OF TRACE METALS IN A SOFT-WATER LAKE. Lancaster Univ. (England). Inst. of Environment and Biological Sciences. For primary bibliographic entry see Field 5B. W91-02587

SEDIMENT-WATER-EQUILIBRIA: THE SORPTION OF VOLATILE CHLORINATED HYDROCARBONS AND DICHLORO BENT-ZENES BY SEDIMENT-WASSER-GLEICHGEWICHTE: VERHALTEN FIUCHTIGER CHLORKOHLENWASSER-STOFFE UND DER DICHLORBENZOLE AN GEWASSERSEDIMENTEN).

Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik. For primary bibliographic entry see Field 5B. W91-02668

HYDROGEOLOGY AND WATER CHEMISTRY IN THE WEATHERED CRYSTALLINE ROCKS OF SOUTHWESTERN NIGERIA.

Loughborough Univ. of Technology (England). Dept. of Civil Engineering.

### Field 2—WATER CYCLE

### **Group 2K—Chemical Processes**

For primary bibliographic entry see Field 2F. W91-02691

FROM RAIN TO LAKE: WATER PATHWAYS AND CHEMICAL CHANGES.

Oslo Univ. (Norway) Dept. of Geology.

I. T. Rosenqvist.

Journal of Hydrology JHYDA7, Vol. 116, No. 1/

4, p 3-10, August 1990. 2 fig, 1 tab, 9 ref.

Descriptors: "Acid lakes, "Acid rain, "Acidic water, "Acidification, "Chemical interactions, "Chemistry of precipitation, "Geochemistry, "Hydrologic cycle, "Soil chemistry, "Water chemistry, "Geochemical interactions, Chemical reactions, Hydrogen ion concentration, Ion exchange, Norway, Soil properties, Soil types.

properties, Soil types.

Southernmost Norway is one of the areas of the industrialized world where many of the streams and lakes are most acid, even though the air and the rainfall is among the least polluted. Chemical composition of stream and lake water depend upon complicated biogeochemical ion exchanges and weathering reactions between precipitation water and permeable material in the catchments. An examination of streams in southern Norway reveals that acid streams are mainly found in areas with sparse mineral soil and acid raw humus (mor) top soils. Changes in vegetation may change mull to mor and vice versa. In addition, three lakes in southern Norway were investigated. Two of them had acid after 1950 and had also acid periods in pre-industrial time following vegetation changes similar to the changes in the twentieth Century. The third lake in a catchment with thick mineral subsoils was never acidified. (Author's abstract) W91-02734

LIMITATIONS TO THE UNDERSTANDING OF ION-EXCHANGE AND SOLUBILITY CONTROLS FOR ACIDIC WELSH, SCOTTISH, AND NORWEGIAN SITES.

Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 5C. W91-02735

ORIGINS OF ACID RUNOFF IN A HILLS-LOPE DURING STORM EVENTS. Sveriges Lantbruksuniversitet, Umea. Dept. of Forest Site Research.

For primary bibliographic entry see Field 5C. W91-02737

EVIDENCE FOR LONG-TERM DETERIORA-TION OF STREAMWATER CHEMISTRY AND SOIL ACIDIFICATION AT THE BIRKENES CATCHMENT, SOUTHERN NORWAY. Senter for Industriforskning, Oslo (Norway). For primary bibliographic entry see Field 5C. W91-02738

REVERSAL OF STREAM ACIDIFICATION AT THE BIRKENES CATCHMENT, SOUTHERN NORWAY: PREDICTIONS BASED ON POTENTIAL ANC CHANGES.

Senter for Industriforskning, Oslo (Norway). For primary bibliographic entry see Field 5B. W91-02739

ELEMENT BUDGETS OF TWO CONTRAST-ING CATCHMENTS IN THE BLACK FOREST (FEDERAL REPUBLIC OF GERMANY). Freiburg Univ. (Germany, F.R.). Inst. of Soil Sci-ence and Forest Nutrition. For primary bibliographic entry see Field 5B. W91-02740

INFLUENCE OF ACID ATMOSPHERIC INPUTS ON SURFACE WATER CHEMISTRY AND MINERAL FLUXES IN A DECLINING SPRUCE STAND WITHIN A SMALL CATCHMENT (VOSGES MASSIF, FRANCE).

Centre National de la Recherche Scientifique,

Strasbourg (France). Centre de Sedimentologie et de Geochimie de la Surface. For primary bibliographic entry see Field 5B. W91-02741

EFFECTS OF VEGETATION TYPE ON THE BIOGEOCHEMISTRY OF SMALL CATCHMENTS (MONT LOZERE, FRANCE).

Orleans Univ. (France). Lab. d'Hydrogeologie. F. Lelong, C. Dupraz, P. Durand, and J. F. Didon-

Journal of Hydrology JHYDA7, Vol. 116, No. 1/ 4, p 125-145, August 1990. 8 fig, 7 tab, 32 ref.

Descriptors: \*Acid rain effects, \*Acidification, \*France, \*Geochemistry, \*Ion transport, \*Land use, \*Path of pollutants, \*Small watersheds, \*Solute transport, \*Vegetation effects, Acid rain, Air pollution, Beech trees, Forest management, Grasslands, Hydrologic budget, Mont Lozere, Soil chemistry, Spruce trees, Sulfates.

Input-output budgets are presented for three gra-nitic catchments, with contrasting vegetation types (Spruce, Beech, and grasslands), for the Mont Lozere region of France. Budget results are com-pared with information for analogous catchments with varying atmospheric pollution loading. Com-parisons show relatively small losses of cations and marked sulfate retention in the soils (particularly for the beech and grassland sites) of the Mont Lozere catchments. Retention of sulfate may be underestimated, particularly for the spruce site. Lozere catchinents. Retention of sunate may be underestimated, particularly for the spruce site, owing to occult and dry deposition inputs which have not been measured. Losses of the base cations are least significant for the beech forest, and this is linked to low bicarbonate production coupled with high sulfate retention in the soil. The spruce affortable programme has led to a marked estimalor inixed to low discretionate production coupled with high sulfate retention in the soil. The spruce affor-estation programme has led to a marked cation-loss increase although the streams have yet to acidify Deforestation leads to further cation losses in rela-Determined the state of the sta

LONGITUDINAL PATTERNS OF CONCENTRATION-DISCHARGE RELATIONSHIPS IN STREAM WATER DRAINING THE HUBBARD BROOK EXPERIMENTAL FOREST, NEW HAMPSHIRE.

Maine Univ. at Orono. Dept. of Plant and Soil For primary bibliographic entry see Field 5B. W91-02743

PRECIPITATION, THROUGHFALL, SOIL SO-LUTION AND STREAMWATER CHEMISTRY IN A HOLM-OAK (QUERCUS ILEX) FOREST. Universidad Autonoma de Barcelona (Spain). Centre de Recerca Ecologica i Aplicacions Fores-

Luss.
F. Roda, A. Avila, and D. Bonilla.
Journal of Hydrology JHYDA7, Vol. 116, No. 1/4, p 167-183, August 1990. 5 tab, 20 ref. CAICYT Project 2129/83.

Descriptors: \*Forest hydrology, \*Geochemistry, \*lon transport, \*Oak trees, \*Precipitation, \*Soil chemistry, \*Streams, \*Throughfall, \*Water chemistry, Acid rain, Calcium, Magnesium, Neutralization, Potassium, Silicates, Weathering.

Bulk precipitation, throughfall, soil solution at 20 and 40 cm depths, and stream water were monitored for 2-4 years in a holm-oak forest on schists in the Montseny Mountains (NE Spain). Bulk precipitation was mildly acidic, with Ca(2+) and SO4(2-) as dominant ions. Canopy interactions produced a throughfall less acidic than bulk precipitation and enriched in all other ions. Large amounts tion and enriched in all other ions. Large amounts of K(+) were leached from the canopy. It is believed that leaching makes a major contribution to Mg (2+) enrichment beneath the canopy. Sulfate was the dominant mobile anion in the soil water, being largely accompanied by Ca(2+). Potassium and NO3(-) were depleted within the soil water with respect to throughfall, probably owing

to biological uptake and cation exchange, and incorporation of K (+) into clay lattices. Subsurface flow dominated the hydrology of the small forested catchment studied. Stream water was basic and rich in bicarbonate. Its chemistry revealed fast rates of weathering of sodium-, and magnesium-bearing silicates (mainly albite and chlorite, respectively). Soil respiration and silicate hydrolysis resulted in HCO3(-) being the dominant mobile anion in stream water. Calcium to chloride ratios were similar in bulk precipitation and in stream water, indicating that Ca (2+) release from weathering has been counteracted by plant uptake. Nutrient uptake by this aggrading forest strongly influences the solution dynamics of K (+). NO3 (-), and Ca (2+). It is concluded that: (1) this forest does not currently receive acidic atmospheric deposition, (2) the neutralization capacity of the soil-bedrock system is quite high, (3) biotic regulation and sliicate weathering are the major processes shaping the solution biogeochemistry in this Mediterranean forest ecosystem. (Author's abstract) W91-02744 W91-02744

HYDROGEOCHEMICAL VARIATIONS IN HAFREN FOREST STREAM WATERS, MID-

Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 4C. W91-02745

PRELIMINARY ANALYSIS OF WATER AND SOLUTE MOVEMENT BENEATH A CONIF-EROUS HILLSLOPE IN MID-WALES, U. K. Polytechnic South West, Plymouth (England).
Dept. of Geographical Sciences.
For primary bibliographic entry see Field 2E. W91-02746

STORMFLOW HYDROCHEMISTRY OF A SMALL WELSH UPLAND CATCHMENT. Institute of Terrestrial Ecology, Bangor (Wales).

Bangor Research Station. Dangor Research Station.

A. D. Muscutt, H. S. Wheater, and B. Reynolds.

Journal of Hydrology JHYDA7, Vol. 116, No. 1/

4, p 239-249, August 1990. 5 fig, 2 tab, 25 ref.

Descriptors: \*Geochemistry, \*Rainfall-runoff relationships, \*Runoff, \*Small watersheds, \*Storm runoff, \*Storm water, \*Water chemistry, \*Weathering, Acid rain, Aluminum, Calcium, Ion transport, Overland flow, Rainfall, Streamflow, Wales.

The hydrochemistry of a small upland catchment during a summer storm, following six weeks of low flow, is described. The storm exhibited several unusual features which may be attributed to the dry antecedent conditions. Streamwater concentrations of all ions analyzed increased during the event but the timing of the increases varied according to the initiation of flows controlling the supply of particular ions. The increase in the concentration of calcium in the stream coincided with ones. or particular ions. The increase in the concentra-tion of calcium in the stream coincided with onset of overland flow, and appears to result from flush-ing of accumulated weathering products from a narrow strip of mire which provides a major path-way for storm water in the catchment. Natural soil pipes appear to be the main source of the increase in streamwater concentrations of both organically in streamwater concentrations of both organically and inorganically complexed aluminum. Concentrations of inorganic aluminum in pipe water were considerably greater than those observed during previous events, possibly another result of the long period without flow. During the stream recession, inorganic aluminum remained high, reflecting a contribution from aluminum-rich throughflow. It is concluded that the chemistry of the stream at any given time is controlled by the relative importance of contributing sources of water which is, in turn, controlled by hydrological factors such as antecedent conditions and rainfall intensity and duration. (Author's abstract) W91-02748

HYDROLOGICAL AND HYDROCHEMICAL FLUXES THROUGH VEGETATION AND SOIL IN THE ALLT A'MHARCAIDH, WESTERN

### Chemical Processes—Group 2K

CAIRNGORMS, SCOTLAND: THEIR EFFECT ON STREAMWATER QUALITY. Macaulay Land Use Research Inst., Aberdeen (Scotland).

For primary bibliographic entry see Field 5B. W91-02749

SHORT-TERM IONIC RESPONSES AS INDI-CATORS OF HYDROCHEMICAL PROCESSES IN THE ALLT A'MHARCAIDH CATCHMENT, WESTERN CAIRNGORMS, SCOTLAND. Freshwater Fisheries Lab., Pitlochry (Scotland). For primary bibliographic entry see Field 5B. W91-02750

EFFECT OF CLEARFELLING A SITKA SPRUCE (PICEA SITCHENSIS) PLANTATION ON SOLUTE CONCENTRATIONS IN DRAIN-AGE WATER.

Institute of Terrestrial Ecology, Grange over Sands (England). Merlewood Research Station. For primary bibliographic entry see Field 4C. W91-02751

GEOCHEMICAL CONTROL OF ALUMINIUM CONCENTRATIONS IN ACIDIFIED SURFACE WATERS.

Oslo Univ. (Norway). Dept. of Chemistry. For primary bibliographic entry see Field 5B. W91-02752

MODELLING STREAMWATER CHEMISTRY AS A MIXTURE OF SOILWATER END-MEM-BERS-A STEP TOWARDS SECOND-GENERA-TION ACIDIFICATION MODELS. Senter for Industriforskning, Oslo (Norway). For primary bibliographic entry see Field 5B. W91-02753

MODELLING STREAMWATER CHEMISTRY AS A MIXTURE OF SOILWATER END-MEM-BERS-AN APPLICATION TO THE PANOLA MOUNTAIN CATCHMENT, GEORGIA, U. S. A. Geological Survey, Doraville, GA. Water Resources Div

For primary bibliographic entry see Field 5B. W91-02754

HYDROGRAPH SEPARATION USING CHEMICAL TECHNIQUES: AN APPLICATION TO CATCHMENTS IN MID-WALES. Institute of Hydrology, Wallingford (England). A. Robson, and C. Neal. Journal of Hydrology JHYDA7, Vol. 116, No. 1/4, p 345-363, August 1990. 6 fig, 6 tab, 29 ref. Department of the Environment Contract PECD 7/10/73.

Descriptors: \*Acid rain effects, \*Acidification, \*Geochemistry, \*Hydrograph analysis, \*Hydrographs, \*Wales, \*Water chemistry, Acid neutralizing capacity, Groundwater, Groundwater chemistry, Hydrogen ion concentration, Land use, Mixing, Model studies, Reforestation, Soil chemistry, Soil water, Storm runoff, Streams.

try, Soil water, Storm runoff, Streams.

A chemical technique is used to provide hydrograph separation for streams in the Llyn Brianne area of Mid-Wales. Hydrograph separation can be employed to determine the relative proportions of each component and the changes in the relative proportions of components, which occur during a storm event. These short-term responses can be combined with the output from long-term models to enable a more comprehensive assessment of sensitivities to acidification. The chemical technique uses mixing relationships for a conservative component, the acid neutralization capacity (ANC). A relationship is established between pH and ANC using the chemical analyses for spot samples and with this the ANC is calculated from continuous pH measurements. The technique separates the hydrograph into soil waters and deeper waters. A comparison of the effects of land-use differences is made. The results suggest that changes in both soil chemistry and hydrological pathways may result from afforestation. Long-term

modeling work may benefit form a combined ap-proach in which mixing-model results are used to allow predictions of short-term stream chemistry changes. (Author's abstract) W91-02755

CONSERVATIVE MIXING OF WATER SOURCES: ANALYSIS OF THE BEHAVIOUR OF THE ALLT A'MHARCAIDH CATCHMENT. Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering. F. M. Kleissen, H. S. Wheater, M. B. Beck, and R.

Journal of Hydrology JHYDA7, Vol. 116, No. 1/4, p 365-374, August 1990. 4 fig, 1 tab, 12 ref.

Descriptors: \*Geochemistry, \*Mixing, \*Runoff, \*Streamflow, \*Streams, \*Water chemistry, Alkalinity, Base flow, Scotland, Soil water, Solutes, Total organic carbon.

Stream chemistry data from the Allt a'Mharcaidh catchment (10 sq km) in Scotland have been the subject of an analysis in which conservative mixing of two sources of constant concentration is assumed for individual chemical species. The mixing analysis has been carried out for alkalinity, silica, calcium, magnesium, sodium, chloride, and total organic carbon (TOC). The analysis shows a consistent behavior of alkalinity and TOC, but other species have an apparently contrasting response. The implications are that event response is due primarily to low alkalinity, shipt TOC water (associated with soil water) and that baseflow is from an unidentified high alkalinity source. However, displacement of alkaline-rich water is apparent during larger events. Other species show contrasting response, possibly as a result of spatial heterogeneity. Despite the fact that many questions remain unanswered, this mixing analysis is a powerful tool for examining the data and can produce hypotheses for more detailed examination. (Author's abstract) W91-02756

METHOD FOR PREDICTING THE EXTREMES OF STREAM ACIDITY AND OTHER WATER QUALITY VARIABLES,
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
For primary bibliographic entry see Field 5B.
W91-02757

TOWARDS DEVELOPING A NEW SHORT-TERM MODEL FOR THE BIRKENES CATCH-MENT-LESSONS LEARNED.

Negrey Vasdrags- og Elektrisitetsvesen, Oslo.
D. Lundquist, N. Christophersen, and C. Neal.
Journal of Hydrology JHYDA7, Vol. 116, No. 1/
4, p 391-401, August 1990. 6 fig, 1 tab, 14 ref.

Descriptors: \*Acid rain effects, \*Aluminum, \*Geochemistry, \*Model studies, \*Norway, \*Soil water, \*Water chemistry, \*Weathering, Calcium, Hydrogen ion concentration, Hydrograph analysis, Hydrographs, Model testing, Oxygen isotopes,

New hydrochemical information is available on soil waters for the Birkenes catchment in southern Norway. This information is in disagreement with the existing Birkenes model: the two reservoirs of the model cannot easily be identified with particular areas or soil horizons in the catchment. Here, a new model is presented allowing such an identification while still representing a simple, lumped structure. The simulated flow patterns in the model are evaluated through a three-step procedure involving: (1) reproduction of the hydrograph, (2) reproduction of the chemically inert (18/D isotope in runoff, and (3) simulation of H(+), Ali) (increasing monomeric aluminum), and Ca in runoff by mixing of measured soil water end member compositions attributed to each model reservoir. The first two tests are met reasonably well within the pro-New hydrochemical information is available on two tests are met reasonably well within the pro-posed structure, whereas the third requirement, if posed structure, whereas the third requirement, if indeed the measured end-member compositions are representative for the catchment, implies structural changes in the way the Birkenes model describes water routing. More field work is required on soil water chemistry, for instance in the deeper layers

in the valley bottom, before a further iteration in model development can be undertaken. (Author's W91-02758

POLYCHLORINATED BIPHENYLS PARTI-TIONING IN WATERS FROM RIVER, FILTRA-TION PLANT AND WASTEWATER PLANT: THE CASE FOR PARIS (FRANCE).

Paris-6 Univ. (France). Inst. d'Hydrologie et de For primary bibliographic entry see Field 5B. W91-02786

DIFFERENCES BETWEEN FRESHWATER AND SEAWATER-ACCLIMATED GUPPIES IN THE ACCUMULATION AND EXCRETION OF TRI-N-BUTYLTIN CHLORIDE AND TRI-PHENYLTIN CHLORIDE.

Shiga Prefectural Inst. of Public Health and Envi-ronmental Science, Otsu (Japan). For primary bibliographic entry see Field 5C.

USE OF KINETIC BIOASSAY PROCEDURE TO ESTIMATE SULFATE AND CYSTEINE CONCENTRATIONS IN SEDIMENT.

Portland State Univ., OR. Environmental Sciences

For primary bibliographic entry see Field 2H.

SEASONAL CHANGES IN IRON TRANSPORT AND NATURE OF DISSOLVED ORGANIC MATTER IN A HUMIC RIVER IN NORTHERN FINLAND.

Oulu Univ. (Finland). Dept. of Botany.

K. Heikkinen

Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 7, p 583-596, November 1990. 3 fig, 6 tab, 60 ref.

Descriptors: \*Dissolved organic carbon, \*Dissolved solids, \*Finland, \*Iron, \*Organic matter, \*River flow, Color, Flooding, Fluorescence, Humic substances, Seasonal variation, Stream dis-

charge.

Seasonal changes in the nature of dissolved organic matter have been reported in streams and organically colored rivers in the boreal region. The changes influence the biology of flowing water an many ways, but are still poorly known and understood. Changes in the concentration of iron and dissolved organic matter (DOM), and in the color and fluorescence properties in the River Liminkkijoki in northern Finland were investigated as functions of the seasonal flow regime over a two-year period. The iron concentration in filtrates and the ratio of iron to dissolved organic carbon (DOC) in the river increased under low flow conditions and decreased during the flood periods. The color of the dissolved organic matter increased with increasing iron content, the effect being more pronounced during the warm period of the year than in winter. The ratio of fluorescence to DOC increased during the warm period of the year but not in winter, and decreased rapidly with discharge at the beginning of the flood period in autumn. The results give indications of the origin, formation, nature and fate of the DOM in the river water. Temperature-dependent microbiological processes in the formation of iron-organic colloids seem to be important. (Author's abstract) W91-02810

CHARACTERIZATION GROUNDWATER IN KOILSAGAR PROJECT AREA, MAHABUBNAGAR DISTRICT, ANDHRA PRADESH, INDIA.

Osmania Univ., Hyderabad (India). C. SudarsanaRaju, and P. V. PrakeshGoud. Environmental Geology and Water Sciences EGWSEI, Vol. 16, No. 2, p 121-128, 1990. 3 fig, 3

### Field 2-WATER CYCLE

### **Group 2K—Chemical Processes**

Descriptors: \*Groundwater quality, \*India, \*Water chemistry, Acidic water, Alkaline water, Anions, Bicarbonates, Calcium, Cations, Ion exchange, Irrigation water, Magnesium, Saline

Studies of groundwater chemistry in the Koilsagar project area of Andhra Pradesh, India, indicate that the waters are sodium bicarbonate, sodium chloride, mixed cationic-mixed anionic, mixed cati-onic Na dominating bicarbonate, and mixed catio-cic Ca dominating bicarbonate types. Of these, sodium bicarbonate and mixed cationic Mg domisodium bicarbonate and mixed cationic Mg dominating bicarbonate types of waters are more prevalent. Isocone mapping of specific conductance indicates that the ionic concentration increases from east to west in the area. Graphical treatment of chemical data reveals that, in general, the area has basic water, whereas the left flank canal area is dominated by secondary alkaline water, and Pallamarri and Pedda Rajmur villages have strongly acidic waters. Ion-exchange studies show that cation-anion exchanges exist all over the area except for two places, which have a base exchange hardened type of water. Graphical representation further shows that most of the area has medium salinity-low sodium (CSI) water useful for irriganurther shows that most of the area has medium salinity-low sodium (C2S1) water useful for irrigation purposes. High salinity-low sodium (C3S1) and high salinity-medium sodium (C3S2) waters are present in some areas, which need adequate drainage to overcome the salinity problem. (Author's abstract) W91-02815

GAMMA EMITTERS IN HONG KONG

Hong Kong Polytechnic, Kowloon. Dept. of Applied Physics. nary bibliographic entry see Field 5B.

ESTIMATION OF THE CONTRIBUTION OF THE SULFATE ION TO RAINWATER ACIDI-

Kanazawa Univ. (Japan). Faculty of Technology. For primary bibliographic entry see Field 5B. W91-02827

ACID DEPOSITIONS, SUMMER DROUGHTS FOREST DECLINE: DEVELOPMENT OF THE NITROUS ACID HYPOTHESIS.

Association pour la Prevention de la Pollution Atmospherique, Bordeaux (France). For primary bibliographic entry see Field 5C. W91-02828

CHEMICAL CONSTITUENTS OF PRECIPITA-TION AND THEIR ROLE IN DETERMINING ITS ACIDITY IN BOMBAY.

Indian Inst. of Tech., Bombay. Centre for Environmental Science and Engineering.
For primary bibliographic entry see Field 5B.
W91-02829

SOURCES AND SINKS OF FORMIC, ACETIC, AND PYRUVIC ACIDS OVER CENTRAL AMA-ZONIA. 2. WET SEASON.

ZUNIA. 2 WEI SEASUN.
National Aeronautics and Space Administration,
Hampton, VA. Langley Research Center.
For primary bibliographic entry see Field 5B.
W91-02838

ATMOSPHERIC SULFUR CYCLE OVER THE AMAZON BASIN. 2. WET SEASON. Florida State Univ., Tallahassee. Dept. of Ocean-For primary bibliographic entry see Field 5B. W91-02839 ography.

DETERMINATION OF PHOTOCHEMICALLY PRODUCED HYDROXYL RADICALS IN SEA-WATER AND FRESHWATER.

Rosenstiel School of Marine and Atmospheric Sci-ence, Miami, FL. Div. of Marine and Atmospheric

For primary bibliographic entry see Field 5A.

W01\_02852

ORIGIN AND EVOLUTION OF FORMATION WATERS, ALBERTA BASIN, WESTERN CANADA SEDIMENTARY BASIN: I. CHEMIS TRY.

TRY, Alberta Univ., Edmonton. Dept. of Geology. C. A. Connolly, L. M. Walter, H. Baadsgaard, and F. J. Longstaffe. Applied Geochemistry APPGEY, Vol. 5, No. 4, p 375-395, July/August 1990. 16 fig. 2 tab, 87 ref. NSF Grant No. EAR-8657180 and NSERC Operating Grant Nos. A7387 and OGP1168.

Descriptors: \*Alberta, \*Connate water, \*Geochemistry, \*Groundwater chemistry, \*Water chemistry, Aliphatic hydrocarbons, Brines, Carbonates, Dissolved solids, Meteoric water.

Formation waters from Devonian through Creta-ceous carbonate and clastic reservoirs in the Alberta Basin were examined for short chained aliphatic acids (SCAs) and major and minor elements. The abundance and distribution of SCA's in Alberta Basin formation waters do not appear influenced or related to reservoir temperature, sampling depth or geological age. However, a strong association between SCA concentration and proximity to the between SCA concentration and proximity to the Jurassic shales is evident, with water washing and meteoric flushing providing a contributing influence. The distinct water groups evident in the Alberta Basin are: (1) Group I waters which are dominantly carbonate hosted and are stratigraphically the lowest; (2) Group II waters which are primarily from clastic reservoirs; and (3) Group III waters which are completely clastic hosted and comprise the stratigraphically highest zone. Group I and II form a distinct hydrochemical regime, which is decoupled from the dilute waters of which is decoupled from the dilute waters of Group III. Group III water chemistry is dominat-ed by Na and HCO3 (alkalinity). Formation waters Group III. Group III water chemistry is cominated by Na and HCO3 (alkalinity). Formation waters from Group I and II form two component mixtures of residual evaporite brine and post Laramide but pre-present day meteoric water. The brine end member was formed by the evaporation of sea water beyond the point of halite saturation, and was not influenced by the congruent dissolution of evaporite deposits. These carbonate hosted waters were subsequently influenced by silicate hydrolysis and clay-carbonate reactions in surrounding shales and ankeritization reactions of reservoir carbonates. The clastic-hosted waters of Group II were affected by feldspar-clay mineral leaching reactions initiated by gravity driven flow of meteoric waters, resulting from Laramide orogenesis. Both Group I and II waters may also have been altered by ion exchange processes. (See also W91-02889) (Lantz-PTI) W91-02888) W91-02888

ORIGIN AND EVOLUTION OF FORMATION WATERS, ALBERTA BASIN, WESTERN CANADA SEDIMENTARY BASIN, II. ISO-TOPE SYSTEMATICS AND WATER MIXING. Alberta Univ., Edmonton. Dept. of Geology. C. A. Connolly, L. M. Walter, H. Baadsgaard, and F. J. Longstaffe. Applied Geochemistry APPGEY, Vol. 5, No. 4, p 397-413, July/August 1990. 9 fig. 2 tab, 62 ref. NSF Grant No. EAR-8657180 and NSERC Operating Grant Nos. A7387 and OGP1168.

ating Grant Nos. A7387 and OGP1168.

Descriptors: \*Alberta, \*Chemical analysis, \*Connate water, \*Geochemistry, \*Groundwater chemistry, \*Isotopic tracers, \*Mixing, \*Sedimentary basins, \*Water chemistry, Deuterium, Hydrological regime, Oxygen radioisotopes, Strontium radioisotopes

Isotopic measurements (Sr, O, D) on formation waters from the Alberta Basin have been made, covering a stratigraphic range from Devonian to Upper Cretaceous. These measurements, combined th chemical compositional trends, give evidence for two distinct water regimes. One hydrological regime is composed of waters hosted in Devonian-Lower Cretaceous reservoirs, the other waters from Upper Cretaceous and younger sedimentary rocks. The waters within the Devonian-Lower Cretaceous regime exhibit a large range in 87-Sr/ 86-Sr values (0.7076-0.7129), but have similar Sr concentrations, regardless of host lithology. Bulk rock and late stage diagenetic cements are less radiogenic than present brines. Importantly, brines from Devonian carbonates possess the most radiogenic Sr isotopic signatures of the waters examined. Devonian shales and/or Cambrian shales may be sources of high 87-Sr/86-Sr ratios in the carbonate hosted waters. Waters from the upper Creta-ceous clastic units, which have ratios as low as 0.7058, and diagenetic cements from Upper Creta-0.7038, and diagenetic cements from Upper Creta-ceous clastic units appear to have precipitated from fluids similar in Sr isotropic value to modern brines. Waters in upper Cretaceous reservoirs have O and D isotopic compositions similar to those of present day rainfall, which in conjunction with very dilute Sr concentrations and low Sr ratios suggest hydrological isolation from the stratigra-phically lower system. (See also W91-02888) (Lantz-PTT) W91-02889

SULPHUR AND OXYGEN ISOTOPES OF DIS-SOLVED SULPHUR SPECIES IN FORMA-TION WATERS FROM THE DOGGER GEO-THERMAL AQUIFER, PARIS BASIN, FRANCE

Bureau de Recherches Geologiques et Minieres,

Bureau de Recherches Geologiques et Minieres, Orleans (France).
C. Fouillac, A. M. Fouillac, and A. Criaud.
Applied Geochemistry APPGEY, Vol. 5, No. 4, p
415-427, July/August 1990. 6 fig. 4 tab, 40 ref.
Bureau de Recherches Geologiques et Miniers DG
12 EN3G 0033F, and The Commission of the
European Communities Contract EN4G 0038F.

Descriptors: \*Connate water, \*France, \*Geochemistry, \*Geothermal water, \*Groundwater chemistry, \*Isotope studies, \*Oxygen isotopes, \*Sulfur, \*Sulfur isotopes, \*Water chemistry, Aquifers, Paris Basin, Sulfates, Sulfides, Sulfur compounds.

Isotopic analysis of the S in sulfides and sulfates Isotopic analysis of the S in sulfides and sulfates from formation waters were made at 35 geothermal wells exploiting the Dogger geothermal aquifer of the Paris Basin. Isotopic analysis of the O of the dissolved sulfates was also made on 12 of these samples. The results show a distribution of the delta-34-S of the sulfates according to geographic zones that also correspond to variations in the geochemistry of the fluids, in particular, the sulfide content. Samples taken in the Seine-St-Denis area and in the areas rooth and west of Peris show, high and in the areas north and west of Paris show high delta-34-S values ranging from +26.3 to +48.9%. Values of delta-34-S for sulfides range from -8.5 to Values of delta-34-S for sulfides range from -8.5 to 5%, and are interpreted as reflecting the effect of bacterial reduction in a confined part of the basin. Modeling this reduction by Rayleigh distillation mechanism made it possible to calculate a value of 1.038 +/-0.003 for the coefficient of fractionation between the sulfides and sulfides. An important part of the sulfides formed by bacterial reduction has been subtracted from the fluid by deposition. has been subtracted from the fluid by deposition. South of Paris and in the Val de Marne, the delta-34-S values for the sulfates are more uniform, ranging between 22.4 and 26.6%, despite the existence of bacterial activity. This is most probably due to a higher rate of flow of the waters, entailing renewal of the sulfate stock. The isotopic composition of the O of the sulfates for the Seine-St-Denis area and the areas weet and porth of Paris is very area and the areas west and north of Paris is very uniform, between 16.1 and 17.1%, despite the wide range in delta-34-S (26.3 to 48.9%) for the same samples. The calculated isotopic temperatures are close to those measured in situ. These results sug-gest either that sulfate water isotopic equilibrium was established after the reduction, or that the coefficient of O fractionation is very low (<1.003) during bacterial reduction. (Author's abstract) W91-02890

METAL-ORGANIC ASSOCIATIONS IN SEDI-MENTS-II, ALGAL MATS IN CONTACT WITH GEOTHERMAL WATERS.

Munich Univ. (Germany, F.R.). Mineralogisch-Petrographisches Inst. For primary bibliographic entry see Field 2J. W91-02892

### Estugries—Group 2L

MODELLING OF THE EVOLUTION OF GROUND WATERS IN A GRANITE SYSTEM AT LOW TEMPERATURE: THE STRIPA GROUND WATERS, SWEDEN.

Paris-7 Univ. (France). Lab. de Geochimie des

D. Grimaud, C. Beaucaire, and G. Michard. Applied Geochemistry APPGEY, Vol. 5, No. 4, p 515-525, July/August 1990. 7 fig, 3 tab, 39 ref.

Descriptors: \*Connate water, \*Geochemistry, \*Groundwater chemistry, \*Model studies, \*Sweden, \*Water chemistry, Aluminum, Chlorides, Granites, Groundwater resources, Minerals.

From previously collected chemical data on Stripa groundwaters, a model of evolution of the chemical composition of groundwater in a granite system at low temperatures is proposed. The existence of two end-member groundwater compositions made it possible first, to test the conventional model of a a possible list, to test the convenional model of a geothermal system according to which an overall equilibrium between the waters and a given miner-al assemblage can be defined, and then to show that such a model could be extended to low temperatures (10 C). Conversely, if the mineral assemblage is known, the equilibration temperature and the charge of the mobile ions (in this case, Cl), the on of the solution is entirely fixed. In this composition of the solution is entirely fixed. In this model of the Stripa groundwaters, the existence of two end-member groundwater compositions can be explained by an evolution from a 'kaolinite-albite-laumonite' equilibrium to a 'prehnite-albite-laumonite' equilibrium, which requiring less Al. The Cl ion concentrations of the groundwaters, are emphasized because they can be considered as indicators of the degree of reaction progress between rock and water, thus determining the degree of equilibration of the system. (Author's abstract) W91-02893

#### 2L. Estuaries

MONTHLY VARIATIONS OF DISSOLVED FREE AMINO ACIDS (DFAA) OBSERVED IN THE BAY OF VILLEFRANCHE-SUR-MER, FRANCE: EXPERIMENTAL STUDY ON THEIR UPTAKE BY PARACENTROTUS LIVIUS AND SPHAERECHINUS GRANULARIS LARVAE (VARIATIONS MENSUELLES DES ACIDES AMINES LIBRES DISSOUS (AALD) PRESENTS EN UN POINT DE LA RADE DE VILLEFERANCHE SIELMED. VILLEFRANCHE SUR-MER: UTILISATION PAR LES LARVES DE PARACENTROTUS LI-VIDUS ET DE SPHAERECHINUS GRANU-LARIS).

LARIS), Institut Oceanographique, Paris (France). Lab. de Physiologie des Etres Marins. J. F. Pavillon, and P. Rault. Aquatic Living Resources ALREEA, Vol. 3, No. 2, p 147-150, 1990. 2 tab, 6 ref. English summary.

Descriptors: \*Amino acids, \*Bioavailability, \*Echinoderms, \*Estuarine environment, \*Larvae, \*Nutrients, \*Villefranche-sur-Mer, Bays, France, High performance liquid chromatography, Season-al variation, Water analysis.

The harbour waters of Villefranche-sur-Mer were In a narrour waters of villetranche-sur-mer were analyzed for dissolved free amino acids dissolved (DFAA), and the consumption of DFAA by larvae was studied to establish a relationship be-tween the concentration of the DFAA, the nature of the DFAA and their consumption by larvae. Sea water was sampled at a depth of seven meters, filtered through a 0.22 micrometer Gelman mem-brane filter and frozen at -70 C. Analysis was carried out by forming a fluorescent derivative with o-phthalaldehyde and 2-mercaptoethanol, folwith o-pathasadenyde and z-mercaptocenano, rol-lowed by HPLC analysis with a fluorescence de-tector on a C-18 column. The mobile phase was sodium acetate and methanol. The laboratory ex-periments were carried out in March and October of 1986 and June of 1987, with sea water taken in December 1985, March and October of 1986 and June of 1987. The larvae were obtained by the method reported by Davis. The pluteus larvae of Paracentrous lividus and Sphaerechinus granularis were used to study the consumption of DFAA. Paracentrous lividus consumed 0.3 to 1.6 microcal/larvae/hr in the endotrophic phase and Sphaerechinus granularis 0.45 to 0.74 microcal/ larvae/hr. During the exotrophic phase the value was 0.08 to 0.7 microcal/larvae/hr for Paracentrotus lividus. The concentration of DFAA in the sea water varied from 640 (June 1986) to 4421 (May 1987) mole/L in the period from October 1985 to June 1987. (King-PTT)

MACROBENTHIC POPULATION OF THE PORT OF ALGIERS (LES PEUPLEMENTS MACRO BENTHIQUES DU PORT D'ALGER). Laboratoire de Chemie Marine, Algiers (Algeria). For primary bibliographic entry see Field 5B. W91-02054

INFLUENCE OF SEDIMENT DISTURBANCE AND WATER FLOW ON THE GROWTH OF THE SOFT-SHELL CLAM, MYA ARENARIA L. Dalhousie Univ., Halifax (Nova Scotia), Dept. of Oceanography. C. W. Emerson.

C. W. Ellierson. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 9, p 1655-1663, September 1990. 4 fig, 2 tab, 42 ref.

Descriptors: \*Clams, \*Environmental effects, \*Flow discharge, \*Growth rates, \*Mollusks, \*Sediment distribution, \*Sediment disturbance, \*Sediment-water interfaces, Bottom sediments, Coastal waters, Flow velocity, Flumes, Laboratory methods, Shear stress.

The importance of sediment disturbance and water flow to the production of the soft-shell clam, Mya arenaria, was assessed in laboratory flumes by measuring growth rates of clams exposed to a gradation of bed shear stress, free-stream velocity, and frequency and depth of sediment disturbance over 10-month period. In the absence of sediment disturbance, growth of soft tissue was directly proportional to both free stream and shear velocity proportional to both free stream and shear velocity (r-squared = 0.64 and 0.72, respectively). Increased organic seston flux may have linked higher water flow to higher growth. In all treatments, maximum growth rates were observed with daily maximum growth rates were observed with daily disturbance of the top centimeter of sediment. No disturbance or me top ceriminate of seament. You bevel of disturbance resulted in growth rates lower than that of undisturbed clams in low flow (free stream velocity of 0.4 cm/s and shear velocity of 0.1 cm/sec). The stimulation of growth under maximum sediment disturbance was removed when free stream velocity exceeded 3 cm/sec. An energy budget for M. arenaria indicated that the amount anic matter suspended during sediment dis-ce was insufficient to account for the increased growth in clams subjected to high levels of disturbance. The sediment disturbance associated with intense clam harvesting, and changes in local hydrography resulting from coastal development, may be responsible for some of the unexplained growth variation in commercial clam stocks. (Au-thor's abstract) W91-02062

SOLUBLE FLUORESCENCE: EFFECTS ON CHLOROPHYLL DETERMINATION AT DIFFERENT SALINITIES.
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
A. A. Keller, L. L. Beatty, L. E. Weber, and C. A.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 9, p 1700-1709, September 1990. 8 fig, 2 tab, 31 ref.

Descriptors: \*Chlorophyll, \*Estuarine environment, \*Fluorescence, \*Laboratory methods, \*Measuring instruments, \*Phytoplankton, \*Salinity, Biomass, Pawcatuck River Estuary, Regression analysis, Rhode Island, Sampling.

Measurements of 3-(3,4-dichlorophenyl)-1,1-dimethylurea (DCMU) enhanced fluorescence, provided reliable estimates of phytoplankton biomass along a salinity gradient when adjusted for soluble enhanced fluorescence, <1 microm size fraction. Positive linear relationships (P<0.0001) were observed between theoreomes and extracted chloroserved between fluorescence and extracted chloro-phyll at salinities of 0, 5, 10 and 30 in experimental

mesocosms and the Pawcatuck River Estuary, Rhode Island, both before and after subtraction of soluble enhanced fluorescence. Adjusting for solusoluble enhanced fluorescence. Adjusting for soluble enhanced fluorescence did not reduce variability in the DCMU enhanced fluorescence to extracted chlorophyll relationships or alter slopes of the regression equations at different salinities. Positive intercepts (which varied with salinity) were, however, reduced to zero after correction. Results further indicated that soluble enhanced fluorescence decreased with increasing salinity (primarily as a result of dilution with seawater), that it was relatively constant at a given salinity, and was unrelated to total DCMU enhanced fluorescence. unrelated to total DCMU enhanced fluorescence. Relying solely on in vivo fluorescence techniques, without correction for soluble fluorescence, would thus increasingly lead to overestimates of phyto-plankton biomass at decreasing salinities. Over the experimental period, 32% (range 8 to 93%) of total DCMU enhanced fluorescence was present in the soluble fraction with the majority (83%) non-photosynthetic material and most likely dissolved humic substances. The soluble fraction and light extinction coefficients were significantly and posiextinction coefficients were significantly and posi-tively related in the mesocosms and the field. (Au-thor's abstract)

DISTRIBUTION OF SHRIMP AND FISH BY-CATCH ASSEMBLAGES IN THE CANADIAN EASTERN ARCTIC IN RELATION IN WATER

Arctic Biological Station, Ste. Anne de Bellevue ebec). C. Hudson

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 9, p 1710-1723, September 1990. 7 fig. 4 tab, 45 ref.

Descriptors: \*Arctic Ocean, \*Canada, \*Fish, \*Shrimp, \*Species diversity, \*Water circulation, Coastal waters, Hudson Strait, Labrador, Latitudinal studies, Salinity, Water temperature.

In the Canadian eastern Arctic, the catches of common species of decapods and fish in bottom trawls reveal a continuum of increasing species richness and abundance in an easterly direction nrciness and aouncance in an easterny direction through Hudson Strait. Species richness is greatest in Ungava Bay, where Arctic and Labrador Sea components of the fauna coexist. Over the study area, species could be divided in three associations corresponding to the origin of the predominant water masses; Arctic cod, cottids, zoarcids, and water masses, Archic con, contain, against masses, injurids predominate in the Arctic waters of western and central Hudson Strait; Greenland halibut, roughhead grenadier, and three-beard rockling are characteristic of the northern Labrador Sea; pancharacteristic of the northern Labrador Sea; pandalid shrimp are abundant in areas of deep (>300), intensely mixed waters near the mouth of Hudson Strait. Pink shrimp (Pandalus borealis) predominates in Davis Strait-Labrador, whereas it is replaced by the striped pink shrimp (P. montagui) in eastern Hudson Strait, reflecting environmental optima in subarctic and Arctic dominated waters, respectively. The yearly catches of striped pink shrimp are highly variable, possibly related to mixing intensity in eastern Hudson Strait. In Canadian Arctic waters, species richness, distribution, and abundance are related to temperature, salinity, mixing, and general circulation of water masses. (Author's abstract) /91-02066

INVESTIGATION OF THE COAGULATION MECHANISM OF THE SUSPENDED PARTIC-ULATE MATTER IN COASTAL WATERS. Patras Univ. (Greece). Physical Chemistry For primary bibliographic entry see Field 2J. W91-02083

CHANGES IN SEASONAL SUCCESSION OF PHYTOPLANKTON INDUCED BY THE STORM-SURGE BARRIER IN THE OOSTERS-CHELDE (S.W. NETHERLANDS). Delta Inst. for Hydrobiological Research, Yerseke

(Netherlands). C. Bakker, P. M. J. Herman, and M. Vink.

Journal of Plankton Research JPLRD9, Vol. 12,

### Field 2—WATER CYCLE

### **Group 2L—Estuaries**

No. 5, p 947-972, September 1990. 9 fig, 3 tab, 58

Descriptors: "Algae, "Algal growth, "Barriers, "Check structures, "Environmental effects, "Estuaries, "Estuarine environment, "Phytoplantton, "Population dynamics, "Succession, "The Netherlands, Hydrodynamics, Light penetration, Oosterschelde Estuary, Salinity, Seasonal variation, Sedimentation, Species composition, Storm surges, Storm water measurement, Storm-surges, barriers, and Storm water measurements, Storm-surges, Storm water measurements, Storm-surges, Storm water management, Storm-surge barrier, Water currents.

Seasonal succession of phytoplankton was followed weekly in the eastern and western parts of the Oosterschelde estuary, before (1982-1983) and during (1984-1986) the construction of the storm-surge barrier. Construction of the barrier seriously during (1984-1986) the construction of the stormsurge barrier. Construction of the barrier seriously
influenced the hydrodynamics of the estuary. In
the eastern part, decreased current velocities led to
the emergence of a vertical sainity gradient, to
increased sedimentation of suspended matter and
to a rise in transparency during a prolonged period
of the year. The relationship between species composition and biomass on the one hand and environmental variables on the other hand was analyzed in
a Canonical Correspondence Analysis, for both
compartments separately. The analysis revealed
that the phytoplankton assemblage more and more
obtained a summer character, extending its growth
season both earlier and later in the year. The
transition of spring to summer phytoplankton assemblages proceeded parallel to the main light
urbdidity gradient. The light factor not only exsemblages proceeded paraliel to the main igni-turbidity gradient. The light factor not only ex-plained the seasonal pattern, but also the long-term trend from pre-barrier to barrier period. Partial Detrended Correspondence Analysis after correc-tion for mean seasonal pattern confirmed this trend significantly. (Author's abstract)

ATTACHED AND FREE-LIVING DIVIDING BACTERIA IN TWO AQUATIC SYSTEMS, Universidad del Pais Vasco, Bilbao (Spain). Dept. de Microbiologia e Inmunologia. For primary bibliographic entry see Field 2H. W91-02121

FACTORS INFLUENCING COMMUNITY STRUCTURE AND DISTRIBUTION OF DIF-FERENT LIFE-CYCLE CATEGORIES OF FISHES IN SHALLOW WATERS OF A LARGE AUSTRALIAN ESTUARY.

AUSTRALIAN ESTUARY, Murdoch Univ. (Western Australia). School of Bi-ological and Environmental Sciences. N. R. Loneragan, and I. C. Potter. Marine Biology MBIOAJ, Vol. 106, No. 1, p 25-37, July 1990. 6 fig, 5 tab, 42 ref.

Descriptors: \*Australia, \*Estuaries, \*Estuarine en-vironment, \*Fish, \*Fish populations, \*Life cycles, \*Species composition, Population density, Salinity, Seasonal variation, Spawning, Swan Estuary, Water temperature.

Fish were collected at regular intervals over 5 yr (February 1977 to December 1981) from ten shallow water sites located throughout the lower, middle and upper regions of the large Swan Estumiddle and upper regions of the large Swan Estuary in temperate southwestern Australia. Analysis of the catch data showed that the total number of species and total density of fishes were both influenced to a greater extent by site and season within the estuary than by year. The number of species and density of fishes within the whole system were greatest during the summer and autumn, when salinities and temperatures were at a maximum, and declined with distance from the estuary and declined with distance from the estuary mouth. The density of marine estuarine-opportunists (species which enter estuaries regularly and in considerable numbers) was also correlated with temperature, reflecting the tendency for species of this category to congregate in the shallows during the summer and autumn. The similar seasonal aggregations of the single anadromous species and gregations of the single anadromous species and species that complete their whole life cycle in the estuary were frequently related to spawning. The density and number of species of the estuarine category were correlated neither with salinity nor with distance from the estuary mouth. The density of freshwater species was inversely correlated with

salinity and positively correlated with distance from the estuary mouth. The composition of the fish fauna changed progressively through the estuary, with that of the lower estuary being the most discrete. The composition also changed seasonally, particularly in the upper estuary where, during the winter and spring, the volume of freshwater discharge increased greatly and as a consequence to winter and spring, the volume of freshwater dis-charge increased greatly and as a consequence the salinity declined markedly. The species character-istic of the lower estuary were generally marine-opportunists, whereas those of the upper estuary typically belonged to either the estuarine or anadromous categories. (Author's abstract)

CARBON BUDGETS OF THE MICROBIAL FOOD WEB IN ESTUARINE ENCLOSURES. Vandkvalitetsinstitutet, Hoersholm (Denmark). B. Riemann, H. M. Sorensen, P. K. Bjornsen, S. J. Horsted, and L. M. Jensen. Marine Ecology Progress Series MESEDT, Vol. 65, No. 2, p 159-170, 1990. 5 fig, 4 tab, 60 ref.

Descriptors: \*Carbon cycle, \*Estuarine environment, \*Food chains, \*Marine bacteria, Biomass, Carbon budgets, Microorganisms, Mussels, Nutrients, Phytoplankton, Primary productivity, Zoo-

During 9 to 25 June 1987, carbon budgets were established for estuarine enclosures manipulated by additions of nutrients and suspension-feeding biadditions of nutrients and suspension-feeding bivalves. An intensive sampling program and a detailed examination of autotrophic and heterotrophic microorganisms enabled construction of
carbon budgets of the microbial food web and
comparison flow rates through a number of microbial components. Phytoplankton biomass and production covaried, and, as expected, lowest values
were recorded in enclosures with added mussels,
and highest values in enclosures with added mussels,
peaked a few days after maxima in phytoplankton
biomass and production. In enclosures with added
mussels, biomasses were lower for bacteria and
microzooplankton, and mesozooplankton, but mussels, biomasses were lower for bacteria and microzooplankton, and mesozooplankton, but slightly higher for heterotrophic nanoflagellates. Bacteria, flagellates, and microzooplankton, mostly ciliates, dominated heterotrophic processes, whereas larger mesozooplankton ingestion did not exceed 5% of phytoplankton primary production. Microzooplankton and flagellate clearances were higher in enclosures with added nutrients, whereas no such changes were found in the macrozooplankton, probably because the duration of the experiments did not allow full development of the macrozooplankton. The added mussels dominated heterotrophic consumption and controlled organisms >20 microns. Exclusion of mussels induced a primary dominance of microzooplankton followed by a subsequent increase of mesozooplankton followed by a subsequen lowed by a subsequent increase of mesozooplank-ton. Additions of nutrients and filtration by suspenton. Adultions of nutrients and infration by suspen-sion-feeding bivalves caused qualitative and quanti-tative changes at all levels in the microbial food web. These changes were measured from a large number of microbial components and allowed balances of the carbon budgets to be made as well as identification of factors controlling the structure and function of the pelagic carbon cycle. (Author's abstract) W91-02125

TIDAL AND TURBIDITY EFFECTS ON THE SHALLOW-WATER FISH ASSEMBLAGE OF

SHALLOW-WATER FISH ASSEMBLAGE OF KUWAIT BAY. Kuwait Univ., Safat. Dept. of Zoology. F. Abou-Seedo, D. A. Clayton, and J. M. Wright. Marine Ecology Progress Series MESEDT, Vol. 65, No. 3, p 213-223, 1990. 6 fig. 8 tab, 31 ref. Kuwait University Grant SZ027.

Descriptors: \*Diurnal distribution, \*Fish, \*Fish populations, "Kuwait, "Marine environment, "Tidal effects, "Turbidity, Biomass, Kuwait Bay, Mud flats, Population density, Sand, Seasonal variation, Shallow water, Species composition.

Effects of location, diel period, tidal condition and water clarity on the size and distribution of the shallow water fish assemblage of the non-estuarine Kuwait Bay were investigated using a beach seine

and a small research trawl during spring and summer 1989. Total numbers, biomass and numbers of species differed markedly between Doha, a sandy shore environment, and Kazmah, an extensive intertidal mud flat. When fish were present in large numbers there was a marked diel effect at both locations with many more fish large numbers there was a marked diel effect at both locations with many more fish captured during the night. Tidal effects were influenced by turbidity and the age structure of the assemblage. In clear water during spring, very young Liza carinata from the seine catches formed shoals at the edge of the rising tide both day and night, while fish 2 mo older formed shoals only on daywhile fish 2 mo older formed shoals only on day-time rising tides. At Kazmah during spring, high turbidity obscured any tidal effects in the seine catches. In slightly deeper water, sampled by trawl during spring, Leiognathus decorus showed an asymmetrical tidal migration. In summer, beach seine catches were much higher on the rising tide. Summer trawl catches did not show a consistent tidal effect. (Author's abstract) W91-02126

CONTROL OF MEIOBENTHIC ABUNDANCE BY MACROEPIFAUNA IN A SUBTIDAL MUDDY HABITAT.

Heriot-Watt Univ., Edinburgh (Scotland). Dept. of **Biological Sciences** 

E. Olafsson, and C. G. Moore. Marine Ecology Progress Series MESEDT, Vol. 65, No. 3, p 241-249, 1990. 7 fig, 62 ref.

Descriptors: \*Fauna, \*Marine animals, \*Marine environment, Benthic environment, Benthic fauna, Copepods, Food chains, Loch Creran, Macrofauna, Marine sediments, Meiofauna, Microfauna, Nematodes, Population density, Scotland.

In order to assess the effects of microfauna in meiofaunal community structure, field investigations were performed in a low energy subtidal muddy sediment Loch Creran, a sea-loch on the west coast of Scotland. Meiofaunal colonization of azoic sediment in cages designed to exclude macrofauna to varying degrees was studied. After 1 mo, nematode density in all 15 cages was less than a third of ambient density. In none of the cages did the nematodes reach ambient densities within the experimental period. Copepods attained background levels in 3 mo in all cages and were in higher numbers in cages designed to exclude all macrofauna. Results indicate that small to medium sized macroepifauna control the densities of copesized macroepifauna control the densities of cope-pods at the study site. (Author's abstract) W91-02127

ANTHROPOGENIC INFLUENCE ON THE IN-TERELEMENTAL CORRELATION IN DIF-FERENT PHASES OF THE MARINE ENVI-

Bulgarian Academy of Sciences, Varna. Inst. of Oceanography.

For primary bibliographic entry see Field 5B.

W91-02175

TRACE METALS IN THE WESTERN MEDI-TERRANEAN SEA. Istituto di Biofisica, Pisa (Italy). For primary bibliographic entry see Field 5B. W91-02179

SURVIVAL OF STRIPED BASS LARVAE AND YEARLINGS IN RELATION TO CONTAMI-NANTS AND WATER QUALITY IN THE UPPER CHESAPEAKE BAY.

Johns Hopkins Univ., Shady Side, MD. Aquatic Ecology Section. For primary bibliographic entry see Field 5C. W91-02199

PREDICTING CONCENTRATIONS OF CONSUMER PRODUCT CHEMICALS IN ESTU-ARIES.

Virginia Univ., Charlottesville. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.

### Estuaries—Group 2L

SURFACE-WATER HYDROLOGY AND SALIN-ITY OF THE ANCLOTE RIVER ESTUARY, FLORIDA.

Geological Survey, Tampa, FL. Water Resources

For primary bibliographic entry see Field 2E. W91-02229

ELEVATED ATMOSPHERIC CO2 EFFECTS ON BELOWGROUND PROCESSES IN C3 AND C4 ESTUARINE MARSH COMMUNITIES. Smithsonian Environmental Research Center. Edgewater, MD.

For primary bibliographic entry see Field 5C. W91-02406

ELEATIONSHIP BETWEEN MIXING PROC-ESS AND CONCENTRATIONS OF MAJOR IONS IN SPANISH MEDITERRANEAN BRACKISH WATERS. Barcelona Univ. (Spain). Dept. de Ecologia. For primary bibliographic entry see Field 2K. W91-02456 RELATIONSHIP BETWEEN MIXING PROC-

TIGRIS-EUPHRATES DELTA: A MAJOR SOURCE OF PESTICIDES TO THE SHATT AL-ARAB RIVER (IRAQ). Best of Environmental Marine Chemistry. For primary bibliographic entry see Field 5B. W91-02463

NUTRIENTS, HEAVY METALS AND ORGANIC MICROPOLLUTANTS IN AN EUTROPHIC BRAZILIAN LAGOON.

Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica. For primary bibliographic entry see Field 5B. W91-02555

PERSISTENCE OF SPILLED CRUDE OIL IN A TROPICAL INTERTIDAL ENVIRONMEN Puerto Rico Univ., Mayaguez. Dept. of Marine

For primary bibliographic entry see Field 5B. W91-02556

TRACE METALS IN THE SEVERN ESTUARY:

A REAPPRAISAL.
Water Research Centre, Medmenham (England).
For primary bibliographic entry see Field 5B.
W91-02557

HYDROCARBON CONCENTRATIONS IN SEDIMENTS AND ANIMAL TISSUES FROM THE COASTAL WATERS OF KARACHI. Karachi Univ. (Pakistan). Inst. of Marine Bio For primary bibliographic entry see Field 5B. W91-02558

OIL POLLUTION IN THE SOUTHERN ARABI-AN GULF AND GULF OF OMAN. Institute of Oceanography and Fisheries, Alexan-

dria (Egypt). For primary bibliographic entry see Field 5B. W91-02559

DEPENDENCE OF ESTUARINE PRODUCTIV-ITY ON ANOMALIES IN MEAN SEA LEVEL. South Carolina Univ., Columbia. Belle W. Baruch Inst. for Marine Biology and Coastal Research. J. T. Morris, B. Kjerfve, and J. M. Dean. Limnology and Oceanography LIOCAH, Vol. 35, No. 4, p 926-930, June 1990. 4 fig. 1 tab, 25 ref. NSF Grants BSR 83-17407 and BSR 85-14326.

Descriptors: \*Ecological effects, \*Estuaries, \*Primary productivity, \*Salt marshes, \*Sea level, Ecosystems, Fisheries, Intertidal areas, Menhaden, Salinity, Shrimp, Spartina.

The annual above ground productivity of Spartina alterniflora in a South Carolina salt marsh varies by a factor of two, and correlates positively (r sq

= 0.99, P < 0.001) with anomalies in mean sea level during the growing season. The effect of sea level anomalies on the salinity of the intertidal sediments probably accounts for the observed changes in primary production. It has also been shown that commercial landings of shrimp and menhaden from the southeastern US Atlantic and central Gulf of Mexico are positively correlated with sea level anomalies. These species use salt marsh habitats as juveniles, and the authors attribute this correlation to effects of sea level anomalies on habitat availability or food production. (Author's abstract) (Author's abstract)

ANNUAL MEAN TRANSPORT IN PUGET SOUND.

National Oceanic and Atmospheric Administra-tion, Seattle, WA. Pacific Marine Environmental Lab.

For primary bibliographic entry see Field 5B. W91-02615

OIL SLICK SIZES AND LENGTH OF COAST-LINE AFFECTED: A LITERATURE SURVEY AND STATISTICAL ANALYSIS-FINAL REPORT. Minerals Management Service, Los Angeles, CA.

Pacific OCS Region.
For primary bibliographic entry see Field 5B.
W91-02671

ANALYSIS OF LONG-TERM SALINITY PAT-TERNS IN THE LOUISIANA COASTAL ZONE, Louisiana State Univ., Baton Rouge. Center for Wetland Resources.

D. A. Fuller, R. E. Condrey, J. P. Geaghan, and B.

Northeast Gulf Science NGSCDE, Vol. 11, No. 1, p 11-17, July 31, 1990. 2 fig, 2 tab, 13 ref.

Descriptors: \*Coastal environment, \*Hydrographic data collections, \*Louisiana, \*Marshes, \*Saline water intrusion, \*Salinity, \*Wetlands, Brackish water, Coastal marshes, Coastal waters, Data collections, Fisheries, Hydrological regime, Salt

Saltwater intrusion is believed to be one of the greatest threats to Louisiana's fishery and wildlife resources. The Louisiana Department of Wildlife and Fisheries has maintained salinity recording stations throughout the state's coastal marshes since the 1960's. We applied several different analytical approaches to the salinity data from 17 stations to determine whether this data base could be used to detect and quantify long-term salinity trends in coastal Louisiana. We did not detect a large-scale, consistent trend over time in coastal salinities across the state. Problems that hindered the detection of long-term trends included short periods of across the state. Problems that inhalted the detec-tion of long-term trends included short periods of record and the placement of the recording stations in salt and brackish marsh areas, where we would in sait and orackish marsh areas, where we would not expect to find great changes in salinity. For the data to be useful in monitoring salinity trends in coastal marshes, especially with respect to salt-water intrusion, stations should be added in fresh and intermediate marshes. In addition, the relationships our study revealed between short-and long-term data indicate that records covering less than a decade are insufficient to denote long-term salinity changes, barring some major modification of the hydrologic regime. (Author's abstract) W91-02762

METHOD FOR THE QUANTITATIVE EVAL-UATION OF FISH MOVEMENTS IN SALT PONDS BY ACOUSTIC TELEMETRY. Centre de Recherche en Ecologie Marine et Aqua-culture, Nieul sur Mer (France). For primary bibliographic entry see Field 7B. W91-02782

CONTROLS AND EFFECTS OF CONTINEN-TAL BRINE FORMATION IN A SUPRATIDAL EPHEMERAL LAKE IN THE SEMI-ARID EN-VIRONMENT OF SPENCER GULF, SOUTH

Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.

For primary bibliographic entry see Field 2H. W91-02806

WITHDRAWAL OF SHELF WATER INTO AN ESTUARY: A BAROTROPIC MODEL.

Delaware Univ., Newark. Coll. of Marine Studies.

Delaware Univ., Newark, Coll. of Marine Studies. A. K. Masse. Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 95, No. 9, p 16,085-16,096, Septem-ber 15, 1990. 12 fig, 27 ref. NSF Grant No. OCE87-11299.

Descriptors: \*Barotropic models, \*Delaware Bay, \*Estuaries, \*Estuarie environment, \*Model studies, \*Water circulation, Bottom circulation, Brackish water, Hydraulic models, Tidal hydraulics, Up-

Coupled circulation between an estuary and the adjacent shelf is a new area of study. At low frequencies estuarine gravitational circulation requires landward flow of lower layer shelf water to balance the seaward flow of brackish estuarine water over the shelf. A clear description of the low frequency physical coupling between the estuary and shelf waters is developed through the use of a and shelf waters is developed through the use of a steady, linear, barotropic model. Complex bottom topography for the shelf is treated. The shelf adja-cent to Delaware Bay, located on the east coast of the U.S. is used as an example. The results show that the landward flow field, driven only by with-drawal of flow through the estuary's entrance, is independent on the flow field otherwise present over the shelf. In the northern hemisphere this landward flow passes along the coast to the right landward flow passes along the coast to the right of the estuary entrance, when viewed facing off-shore, before it enters the estuary. Model results are supported by near bottom current observations collected on the shelf adjacent to the mouth of Delaware Bay. (Author's abstract) W91-02831

SOME OBSERVATIONAL EVIDENCE ON THE EFFECT OF ATMOSPHERIC FORCING ON TIDAL VARIABILITY IN THE UPPER DELAWARE BAY.

WARE BAY.
Delaware Univ., Newark. Coll. of Marine Studies.
K. C. Wong, and J. H. Trowbridge.
Journal of Geophysical Research (C) Oceans
JGRCEY, Vol. 95, No. 9, p 16,229-16,240, September 15, 1990. 11 fig. 29 ref. NSF Grant Nos. OCE8515735 and OCE87-10768; NOAA Office of Sea Grant No. NA86AA-D-SG040

Descriptors: \*Atmospheric circulation, \*Delaware Bay, \*Estuaries, \*Tidal hydraulics, \*Tides, \*Wind tides, Estuarine environment, Oceanography, tides, Estuarie Wind pressure.

Until recently, most oceanographic research relating to the tidal variability in an estuary has ignored the effect of atmospherically forced motions on tidal motions. Mechanisms exist through which high frequency wind waves and low frequency subtidal variability can interact nonlinearly with the tide, and modify the tidal response of an estuary significantly. A set of current and sea level observations in the upper Delaware Bay provides observational evidence which suggests that tidal variability in the interior of the bay was appreciably modified during two moderately strong atmospheric events. The observed order of magnitude of changes in tidal characteristics can be explained by changes in tidal characteristics can be explained by interactions of the tide with surface waves and subtidal motions. The dominant mechanism in wave current interaction is the turbulent wave wave current interaction is the turbulent wave boundary layer, which enhances the frictional at-tenuation of the tide. Changes in propagation and attenuation characteristics due to subtidal depth changes have a smaller but still observable effect. (Lantz-PTT) W91-02833

MONITORING AND ASSESSMENT OF MER-CURY POLLUTION IN THE VICINITY OF A CHLORALKALI PLANT: I. DISTRIBUTION,

### Field 2—WATER CYCLE

### **Group 2L—Estuaries**

AVAILABILITY AND GENOTOXICITY OF SEDIMENT MERCURY IN THE RUSHIKULYA ESTUARY, INDIA. Berhampur Univ. (India). Dept. of Botany. For primary bibliographic entry see Field 5B. W91-02932

STUDY ON THE HYDROLOGY AND PHYTO-PLANKTON OF THE VARANO LAKE (ADRI-ATIC SEA) DURING AN ANNUAL CYCLE (MAY 1985-APRIL 1986). (ETUDE SUR LAC DE VARANO (MER ADRIATIQUE): MAI 1985-

VARANU (MEX ADMINISTRATION OF BIOLOGY.
Padua Univ. (Italy). Dept. of Biology.
C. Tolomio, C. Andreoli, and M. Montanari.
Archiv fuer Hydrobiologie, Supplement AHBSA8,
Vol. 83, p. 57-85, August 1990, 26 fig, 3 tab, 41 ref.

Descriptors: \*Adriatic Sea, \*Hydrology, \*Italy, \*Lagoons, \*Lakes, \*Multivariate analysis, \*Phytoplankton, \*Seasonal variation, Coastal environment, Diatoms, Dystrophic lakes, Lake Varano, Nanoplankton, Physicochemical properties, Picoplankton.

A 12-month study was made on the principal environmental factors affecting the physico-chemical properties and phytoplankton of Lake Varano. High levels of oxygenation, nitrates and phosphates with uniform levels of pH and salinity contributed to the high density of phytoplankton during the entire study period. Picoplankton, nanoplankton and diatoms were dominant especially during summer. Multivariate analysis of the data indicated that both the physico-chemical and biological conditions of this environment are greatly influenced by the seasons. Also, the two mouth canals are major factors that cause the dystrophic characteristics of this lake. Compared with other latlaina coastal environments, this area is scarcely affected by anthropogenic factors. (Medina-PTT) W91-02934 A 12-month study was made on the principal envi-

STATE OF THE CHESAPEAKE BAY.
For primary bibliographic entry see Field 5G.
W91-02956

### 3. WATER SUPPLY AUGMENTATION AND CONSERVATION

### 3A. Saline Water Conversion

RECOVERY OF MINERAL SALTS AND POTA-BLE WATER FROM DESALTING PLANT EF-FLUENTS BY EVAPORATION, PART II, PRO-POSED SIMULATION SYSTEM FOR SALT

University of Petroleum and Minerals, Dhahran (Saudi Arabia). Dept. of Chemical Engineering. H. K. Abdel-Aal, K. M. Ba-Lubaid, A. A. Shaikh, and D. K. Al-Harbi.

Separation Science and Technology SSTEDS, Vol. 25, No. 4, p 437-461, April 1990. 11 fig, 7 tab,

Descriptors: \*Desalination plants, \*Desalination Descriptors: "Desamation plants, "Separation techniques, "Waste recovery, "Water reuse, Brines, Magnesium compounds, Mathematical models, Potable water, Saudi Arabia, Simulation analysis, Sodium chloride

Salt recovery from rejected brines of the Al-Khobar Water Desalination Plant, Saudi Arabia, is studied through the simulation of a modified multistage flash evaporator system. Two phases of concentration are planned: Phase I will concentrate the main effluent from 6.4 wi% total salt to 28.8%, while Phase II will use the effluents from 28.5%, while Praise It will use the entirents from Phase I as a feed to undergo further evaporation and cooling. NaCl and water are produced throughout this phase, while the end residue prod-uct will be essentially MgCl2, since it is the most soluble. A mathematical model is developed and ed to perform stage-to-stage material and heat lance calculations. Concentrations of NaCl and

MgCl2 in the streams entering and leaving a stage MgCl2 in the streams entering and leaving a stage are determined by using the solubility correlation developed in Part I. Simulation results show that by using 5210 tons/h brine as a feed for Phase I, 4430 tons/h fresh water, 277 tons/h NaCl and 502 tons/h 'bittern' (in which the ratio of MgCl2/NaCl is increased to 12) are recovered as the very final products of the integrated scheme. This bittern provides 30 tons/h MgCl2 as an end product. (Author's abstract) (Author's abstract) W91-02402

LEIGH CREEK TOWN WATER SUPPLY-A

For primary bibliographic entry see Field 5F. W91-02528

### 3B. Water Yield Improvement

IMPROVED YIELD OF RURAL WATER WORKS THROUGH HYDRAULIC FRACTURING EXPERIMENTS (AMELIORATION DE LA PRODUCTIVITE DES OUVRAGES D'HYDRAULIQUE YILLAGEOISE PAR FRACTURALION HYDRAULIQUE EXPERIMENTATION). Bureau de Recherches Geologiques et Minieres, Orleans (France). Water Resources Dept. For primary bibliographic entry see Field 4B. W91-02335

USE OF RUN OFF ON CULTIVATED FIELDS IN THE SUDAN-SAHELIAN AREA: BURKINA FASO, YATENGA PROVINCE, BIDI REGION (VALORISATION AGRICOLE DES EAUX DE RUISSELLEMENT EN ZONE SOUDANO SA-HELIENNE: BURKINA FASO, PROVINCE DU

THELIENNE: BURKINA FASO, PROVINCE DU YATENGA, REGION DE BIDD.
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Ouagadougou (Burkina Faso). Centre ORSTOM a Ouagadougou. For primary bibliographic entry see Field 3F. W91-02365

TAPPING OF WATER HOLES FROM TEMPO-TAPPING OF WATER HOLES FROM TEMPOYERARY SURPACES TO IMPROVE SAHELIAN PASTURELAND MANAGEMENT (EXPLOITATION DE POINTIS D'EAU DE SUFFACE TEMPORAIRES POUR L'AMELIORATION DE LA GESTION DES PATURAGES SAHELIENS). Office de la Recherche Scientifique et Technique Outre-Mer, Montpellier (France). Lab. d'Hydrolo-

P. Chevallier, and J. Claude. P. Chevallier, and J. Claude. IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouaga-dougou, Burkina Faso, 18-23 February 1989. Inter-national Water Resources Association, Urbana, Il-linois. 1990. p 946-956, 3 tab, 15 ref. English sum-

Descriptors: \*Developing countries, \*Sahel, \*Water holes, \*Water supply, \*Water tanks, Cattle, Evapotranspiration, Groundwater, Management ing, Social aspects, Water conservation

In the Sahelian cattle breeding areas, the explora-tion of natural resources must emphasize their fra-gility and must spread the sampling in space and time. The concentration of cattle around water points leads to the degradation of surrounding pastures. A study of water transfers made two main points clear: (1) loss of water by evapotran-spiration can be higher than 2000 mm and (2) surface runoff constitutes an abundant water re-source. To spread the water resource in time and surface runoff constitutes an abundant water resource. To spread the water resource in time and space, small equipment is proposed (tanks, over-deepening of pools). By taking account of traditional breeding systems in this way, recourse to the exploitation of underground resources often can be avoided, thus eliminating the need for development of technical and sociological infrastructure that the society cannot support. (See also W91-02288) (Rochester-PTT) W91-02366

HARVEST OF EPHEMERAL RUNOFF FOR ARTIFICIAL GROUNDWATER RECHARGE:

FEASIBILITY EVALUATION USING HYDRO-LOGICAL AND HYDROGEOCHEMICAL MODELS

Nevada Univ. System, Las Vegas. Water Re-G. F. Cochran, J. R. Barry, M. W. Dale, and P. R.

Sones.

In: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 471-485, 3 fig, 10 ref.

Descriptors: \*Aquifer management, \*Artificial re-charge, \*Groundwater management, \*Groundwater resources, \*Water harvesting, \*Water resources management, \*Water supply development, Draw-down, Economic aspects, Ephemeral streams, Groundwater recharge, Hydrologic budget, Hydrologic models, Model studies, Nevada, Runoff, Surface runoff, Watershed management.

The economic and technical feasibility of harvesting ephemeral runoff for artificial recharge of overdrafted aquifers in a topographically closed basin in western Nevada were investigated. Groundwater provides 80% of domestic water for the basin's 15,000 residents. Spring runoff, which is highly variable and of short duration, does not occur during peak demand periods thus precluding direct willigation. Because there are no surface occur during peak demand periods thus precluding direct utilization. Because there are no surface storage reservoirs, the runoff is lost to evaporation from shallow, valley-bottom playas. Use of over-drafted aquifers to store harvested water and supplement supplies appears economically feasible compared to costs for alternate supplies. Donor area water balance and groundwater models which were developed indicate significant harvestable water. Groundwater simulation and geochemical models were used to select best recharge locations and study recharge effects. It was determined that, with this artificial recharge scenario, water levels in the central and northern portion of the valley would continue to decline but at a lower rate, experiencing up to 3 m less drawdown than without recharge operations. (See also W91-02672) (Author's abstract)

### 3C. Use Of Water Of Impaired Quality

RAPID EVALUATION OF SALT TOLERANCE OF MANGROVE-SWAMP RICE VARIETIES.

Regional Mangrove Swamp Rice Station, Rokupr (Sierra Leone). M. P. Jones

Tropical Agriculture TAGLA2, Vol. 67, No. 3, p 199-202, July 1990. 3 fig, 2 tab, 12 ref.

Descriptors: \*Developing countries, \*Mangrove swamps, \*Plant water potential, \*Rice, \*Roots, \*Salinity, \*Salt tolerance, Physiological ecology, Plant growth, Resource conservation, West Africa.

In West Africa, an estimated 1,500,000 ha of cultivatable mangrove swamps are affected by salinity. The identification or development of salt-tolerant The identification of development of sair-toferant rice varieties could be of considerable benefit in the stabilization of rice production and expansion of cultivatable areas in mangrove swamps. Salinity tolerance of rice varieties was determined by comtolerance of new valueurs was determined by com-parative measurement of seedling root growth in saline and in non-saline conditions. A tolerance ratio (TR) of root growth after four days in 80 mM sodium chloride solution to root growth after four days in normal culture solution was calculated for each individual within a variety. The technique was used to screen 1058 varieties/advanced lines available at the WARDA-Rokupr Station and was available at the WARDA-Rokupr Station and was found to be reliable, rapid and simple. Substantial variation in seedling tolerance to salinity was found within and between varieties and populations bearing the same variety name. The seedling TR was correlated with the visual scores (r = 0.80, df = 1058, P < 0.001) of salt symptoms and survival (r = 0.75, df = 1058, P < 0.001) at 80 mM sodium chloride solution. The scores after four weeks of plant exposure to 80 mM sodium chloride confirm the ranking of the varieties on the

#### WATER SUPPLY AUGMENTATION AND CONSERVATION—Field 3

Conservation In Agriculture—Group 3F

basis of the TR. While visual scores can be subjective, the TRs were obtained from root length tive, the IRs were obtained from root length which is a quantitative characteristic. Humidity and temperature appeared to affect the germination and rate of root growth, thereby affecting the TR. The changes in TR due to seasonal drift were overcome by adjusting the TRs of all test varieties with the TR of the tolerant check. The method of comparing rate of root growth of one-week-old rice seedlings in normal and 80 mM sodium chloride solutions provided a quick, reliable and simple technique of screening rice varieties and breeding lines for salinity tolerances. (Author's abstract)

GUIDELINES FOR DEVELOPING

Freese and Nichols, Inc., Fort Worth, TX.
For primary bibliographic entry see Field 6B.
W91-02567

GROUNDWATER MANAGEMENT STRATEGY FOR SALINITY MITIGATION IN THE VICTO-RIAN RIVERINE PLAIN, AUSTRALIA. Rural Water Commission of Victoria, Armidale (Australia).

R. S. Evans, and J. Nolan.
IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 487-499, 5 fig, 2 ref.

Descriptors: \*Aquifer management, \*Groundwater management, \*Groundwater resources, \*Irrigation effects, \*Irrigation water, \*Saline groundwater, \*Saline soils, \*Water resources management, "Water supply development, Australia, Conjunc-tive use, Groundwater irrigation, Groundwater po-tential, Groundwater recharge, Land use, Re-source allocation, Water allocation, Water table rise, Waterlogging.

Groundwater management for salinity purposes requires a significant change of thinking compared to management for 'stressed' aquifers. The recognition that groundwater quality decrease is a primary factor controlling groundwater quantity allocation represents a significant change of thinking compared to conventional management of the re-used groundwater is paramount. The long-term viability of agriculture in the Riverine Plain of Northern Victoria, Australia, is now threatened by land salinization and waterlogging; a direct result of increased rates of recharge to groundwater in response to clearing of natural vegetation and intensions. creased rates of recharge to groundwarer in re-sponse to clearing of natural vegetation and inten-sive irrigation. Without large scale dewatering, the groundwater system is unable to dissipate the in-creased recharge, hence water tables will continue to rise and exacerbate the existing problem. A groundwater management strategy is based on engroundwater management strategy is obsect on en-couraging groundwater development. The princi-ple constraints on such development are the need for control of aquifer salinity and salt export, in the context of an overall conjunctive use policy. Specontext of an overall conjunctive use poncy. Spe-cific strategy initiatives to encourage an appropri-ate and sustainable level of groundwater use in-clude: integrated water allocation and management policy, definition of salt export criteria, and com-munity education. (See also W91-02672) (Author's

#### 3D. Conservation In Domestic and Municipal Use

WATER CONSERVATION IN DROUGHT-STRICKEN SANTA BARBARA COUNTY--RE-SPONSE IS SLOW.

Lawrance, Fish and McFarland, Inc., Santa Bar-

bara, CA. C. H. Lawrance.

iblic Works PUWOAH, Vol. 121, No. 10, p 102-103, September 1990. 3 tab.

Descriptors: \*California, \*Domestic water, \*Water conservation, \*Water shortage, \*Water use, Analytical methods, Biochemical oxygen demand,

Conservation, Environmental protection, Municipal water, Water demand.

For several years, most of the public water supply agencies in Santa Barbara County, California have encouraged their customers to conserve water. encouraged their customers to conserve water. The urgency for consumer conservation has increased since 1988, and has become critical for portions of Santa Barbara County that rely to a significant extent on surface water supply. Enlisting the cooperation of all municipal sewering agencies within Santa Barbara County, Lawrance, Fisk and McFarland, Inc. obtained and analyzed municipal wastewater treatment plant data for 1983 to 1989 in order to study interior water usage. Average dry-weather flow, estimated tributary population, and representative influent concentrations of 5-day biochemical oxygen demand and suspended solids were examined. The year 1983 was selected because is was the most recent very wet year in solids were examined. The year 1983 was selected because is was the most recent very wet year in Santa Barbara County. Using the data submitted, per capita wastewater flows and organic contributions for each year were calculated. Results showed that only one community was experiencing significant effects of interior water conservation, as registered by a consistent decrease in average dry-weather flow and per capita wastewater flows and a corresponding increase in influent biological oxygen demand. The water purveyor serving this particular community had an unusually logical oxygen demand. Ine water purveyor serv-ing this particular community had an unusually aggressive retrofit campaign for toilets and shower heads for a number of years. This activity appar-ently was paying off in terms of reduced interior water usage. (Mertz-PTT) W91-02423

#### 3E. Conservation In Industry

MODELS FOR A RATIONAL UTILIZATION OF HIGH QUALITY GROUNDWATER RESOURCES.

Dortmund Univ. (Germany, F.R.). Inst. for Environmental Protection.

I. Heinz.
I.N: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 515-522, 1 tab, 3 ref.

Descriptors: \*Germany, \*Groundwater management, \*Groundwater resources, \*Industrial water, \*Model studies, \*Taxes, \*Water conservation, \*Water resources management, \*Water use efficiency, Drinking water, Economic justification, Water allocation, Water demand, Water pollution.

Increasing demands are being placed on high grade quality drinking water, as a result of the continuing pollution in the Federal Republic of Germany. Consequently, the need has arisen for water utilization to become as efficient as possible. Approaches in this direction have already been made in industry where engineers have intensified the search for try where engineers have intensified the search for water-saving techniques in the manufacturing process. Optimal allocation of water resources may be achieved by introducing a groundwater intake levy in order to push industry in particular towards a maximally efficient water utilization. The starting point is a supply deficit of high quality groundwater in any given area due to increasingly higher drinking water needs and/or growing pollution of water by toxic substances. Using the example of a regional model, the conditions for an economically effective allocation of water resources for both industry and the public water supply, can be seen from an ecological standpoint. The optimal rate for a water intake levy is determined with the assistance of an iteration procemined with the assistance of an iteration procemined with the assistance of an iteration proce-dure. In 1988, a water intake levy was introduced in the State of Baden-Wurttemberg in the Federal Republic of Germany. The levying of this charge on all water users (on both groundwater and sur-face water) is now being retrospectively justified by the argument that a more efficient utilization of oy the argument mat a more ernicient unitration or water has been created and that, in the future, the price of natural resources should no longer be fixed at zero. Such a levy can only bring about a more thrifty utilization of precious water supplies. (See also W91-02672) (Fish-PTT)
W91-02715

#### 3F. Conservation In Agriculture

SCREENING FOR DROUGHT TOLERANCE: SOYBEAN GERMINATION AND ITS RELA-TIONSHIP TO SEEDLING RESPONSES. Alabama A and M Univ., Normal. Dept. of Plant and Soil Science.

B. K. Kpoghomou, V. T. Sapra, and C. A. Beyl. Journal of Agronomy and Crop Science ZAPFAR, Vol. 164, No. 3, p 153-159, April 1990. 4 fig, 1 tab, 14 ref. CSRS/USDA Grant No. 2-01-14-3151.

Descriptors: \*Crops, \*Drought resistance, \*Soil-water-plant relationships, \*Soybeans, Drought effects, Germination, Leaves, Osmoregulation, Plant growth, Plant water potential, Stress, Vegetable crops, Water use.

Soybean has a peak daily water use of 8.5 ml Soybean has a peak daily water use of coloring the growing season and is very sensitive to water stress. Seventeen determinate soybean (Glywater stress.) cine max L.) cultivars from maturity groups through VIII were screened for drought toleran cine max L.) cultivars from maturity groups V through VIII were screened for drought tolerance during germination and seedling stages. Ultimately, this information may be used to predict the field performance of selected varieties under actual drought conditions. Germinating seeds and hydroponically-grown seedlings were subjected to osmotic stresses of about 0.3 and 0.5 MPa using polyethylene glycol M.W. 8000. Genotypic variability was found among the cultivars for all the parameters analyzed in both germination and seeding tests. Germination stress index was lower for seeds exposed to about 0.5 MPa than for about 0.3 MPa osmotic stress. Lower osmotic potential in the treatment medium was also correlated with lower leaf water potential in seedlings. A significant relationship was found between fresh weight and height stress indices. The cultivars that grew taller under drought stress conditions had greater dry matter accumulation and higher germination stress indices, indicating the reliability of height to predict cultivar performance under such conditions. In the seedling tests, there was no strong relationship between the leaf water potential and the overall performance of the plant, suggesting no clear osmoregulatory mechanism. (Author's abstract) stract) W91-02074

INFLUENCE OF PLANT WATER STRESS ON NET PHOTOSYNTHESIS AND LEAF AREA OF TWO MAIZE (ZEA MAYS L.) CULTIVARS. Orange Free State Univ., Bloemfontein (South Africa). Faculty of Agriculture. J. J. Human, W. H. DuPreez, and L. P. DeBruyn.

Journal of Agronomy and Crop Science ZAPFAR, Vol. 164, No. 3, p 194-201, April 1990. 4 fig, 4 tab, 18 ref.

Descriptors: \*Corn, \*Crops, \*Drought resistance, \*Plant growth, \*Plant water potential, \*Soil-water-plant relationships, \*Water stress, Absorption, Leaves, Photosynthesis, Vegetable crops.

Yield reduction caused by plant water stress can be attributed directly to inhibition of the carbon diox-ide uptake rate. The effect of plant water stress on net photosynthesis and leaf growth were investi-gated in order to determine how much leaf water gated in order to determine how much leaf water potential during vegetative growth and silking affects maize development. Two commercial maize hybrids grown in pots in a glasshouse were subjected to leaf water potentials of approximately 1300 and 1700 kPa during the eighth leaf stage and during silking to approximately -1700 and -2300 kPa to previously unstressed, moderately, and severely stressed plants. The effect of stress on inhibiting carbon dioxide uptake rates and leaf areas, as well as the recovery after alleviating stress, were compared to that of unstressed plants. No substantial differences in carbon dioxide uptake rates were found between medium and long seasoned cultivars. The carbon dioxide uptake rates per unit leaf vars. The carbon dioxide uptake rates per unit leaf area decreased to negative values under both modarea decreased to regative values under our mod-erate and severe stress conditions during both growth stages. During silking, the recovery of carbon dioxide uptake rate was much lower than during the eight leaf stage. Leaf area decreased

#### Field 3—WATER SUPPLY AUGMENTATION AND CONSERVATION

#### Group 3F-Conservation In Agriculture

proportionally with increased stress but did not proportorially with increased stress out that not recover after alleviating stress on plants stressed during both the eighth leaf and silking stages. These findings indicate increased resistance to water stress with increased plant age. (Author's abstract) W91-02075

RAPID EVALUATION OF SALT TOLERANCE OF MANGROVE-SWAMP RICE VARIETIES. Regional Mangrove Swamp Rice Station, Rokupr (Sierra Leone).

For primary bibliographic entry see Field 3C. W91-02077

WATER VAPOR TRANSPORT THROUGH A FLAIL-CHOPPED CORN RESIDUE.

Wisconsin Univ., Madison. Dept. of Soil Science. C. B. Tanner, and Y. Shen.

Soil Science Society of America Journal SSSJD4, Vol. 54, No. 4, p 945-951, July/August 1990. 4 fig,

Descriptors: \*Corn, \*Evaporation, \*Water transport, \*Water vapor, Conductance, Convection, Crop residues, Crops, Evaportanspiration, Field tests, Flail-chopping, Regression analysis, Vapor pressure, Wind velocity.

Crop residue at the soil surface is known to de-crease evaporation, and measurements have shown that wind increases evaporative loss through resi-dues; however, measurements of water vapor flux through residues have not defined their vapor conductance. Water vapor transport through crop residues was measured in a wind tunnel and under idues was measured in a wind tunnel and under natural wind in order to parameterize the vapor conductance in a way useful for modeling the energy balance of conservation-tillage systems. The vapor conductance of ffail-chopped corn (Zea mays L.) residue laid over large vapor sources (0.15 by 1.2 m) at different vapor pressure gradients was measured in still air and under winds. In ents was measured in still air and under winds. In still air, the vapor conductance of 10 samples of residue (areal density, 0.4 kg/sq m; average thickness, 11 mm) averaged 2.2 mm/s at 20 C and was not significantly different than the conductance of a similar thickness of air. Error in the measurement (CV=13%) was sufficient that porosity and tortustits of the conductance osity effects could not be determined. Buoyancy-driven convection in the flail-chopped residue was negligible under much greater buoyancy instabil-ities than are likely to occur in the field. The vapor inces than are miscry to occur in the relat. The vapor conductance of nine samples of residue measured in a wind tunnel increased linearly with wind speeds measured at 1 m above the residue. The regression coefficients of vapor conductance versus wind found in the wind tunnel and under natural winds did not differ. It is suggested that conductance measurements of other residues would be done much more easily in a suitable wind tunnel than in the field, and with the same results. (Author's abstract) 91-02130

COUPLED WATER AND HEAT TRANSPORT IN RIDGED SOILS.

Iowa State Univ., Ames. Dept. of Agronomy. For primary bibliographic entry see Field 2G. W91-02133

POLYMER EFFECTS ON EROSION UNDER LABORATORY RAINFALL SIMULATOR CON-DITIONS.

Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center. For primary bibliographic entry see Field 2J. W91-02137

GUIDELINES AND INTEGRATED MEASURES FOR PUBLIC HEALTH PROTECTION IN AG-RICULTURAL REUSE SYSTEMS.

World Health Organization, Geneva (Switzerland). Div. of Environmental Health. For primary bibliographic entry see Field 5E. W91-02142

IMPACT OF WATER CONTROL ON NAVAJO IRRIGATION PROJECTS. Colorado State Univ., Fort Collins. Dept. of Civil

Engineering.

J. W. Leener

Engineering.

J. W. Leeper.

IN: Indian Water Rights and Water Resources

Management. Proceedings of a Symposium. American Water Resources Association, Bethesda,

Maryland. 1989. p 165-174, 1 fig, 6 tab, 11 ref.

Descriptors: \*Agricultural water, \*Indian reserva-tions, \*Indian water rights, \*Irrigation practices, \*Water management, \*Water resources manage-ment, Navajo Indians, Social aspects.

Navajo irrigation systems have been plagued with poor performance. Many theories have been proposed to explain this poor performance including: small economically non-viable farm size, lack of maintenance, lack of funding, institutional conflict, lack of extension/technology, lack of credit, lack of education, and/or irrigated agriculture is culturally unaccepted. Based on past experience with Navajo irrigation, many authorities do not believe that small-scale irrigated agriculture is culturally or economically viable. Based on system-wide data from 83 Navajo irrigation projects, farm data from or economically viable. Based on system-wide data from 83 Navajo irrigation projects, farm data from over 600 Navajo farmers and comparisons with non-Navajo systems, one of the primary con-straints on these systems is a lack of physical and straints on these systems is a lack of physical and organizational control over water. Resources expended on education, extension or exotic crops, will have little impact on farm performance if water control is lacking. On the Navajo Reservation, in spite of small farm size, because of no access to financing and insufficient extension services, farmers who have control of their water are ices, farmers who have control of their water are using it. The farms at the head of the Fruitland system, for instance, have a cropping intensity of almost 80%. Even on the Fruitland system, although the water supply is adequate, it is not reliable, nor is it distributed equitably. Without water control, most of the farms experience crop threatening water shortages sometime during the water season. (See also W91-02262) (Lantz-PTT) W91-02278

HYDRAULIC WORKING OF SHALLOW WATERS IN WEST AFRICA (FONCTIONNE-MENT HYDROLOGIQUE DES BAS FONDS EN AFRIQUE DE L'OUEST).

AFRIQUE DE L'OUEST).
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Dakar (Senegal).
Centre de Dakar.
For primary bibliographic entry see Field 4A.
W91-02314

IRRIGATION TRIALS: BASIS FOR THE DESIGN OF FURROW SYSTEMS.

Irrigation Development Authority,

(Ghana).

H. K. Nyaledzigbor.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 343-351, 5 fig, 2 tab, 2 ref.

Descriptors: \*Agriculture, \*Furrow irrigation, \*Ghana, \*Irrigation design, Design criteria, Developing countries, Economic aspects, Infiltration, Semiarid lands.

Applied research was carried out to investigate Applied research was carried out to investigate water intake, furrow lengths, and gradients for the design of a furrow irrigation system. The study aimed to develop well-designed fields with furrows of economical length and gradient and to investigate the operational parameters of lead stream size and duration to assist operational planning for the irrigation system. Furrow trials were established on the soils of an irrigation project during its on the soils of an irrigation project during its design phase (semi-arid savanna zone of Ghana). The trials measured cumulative infiltration by furrow infiltration tests and investigated lead stream sizes for various furrow lengths and gradients. From the trial results it was possible to select an adequate furrow length and gradient for the layout design of the project. It also was possible to recommend the range of lead streams to achieve

adequate water application, as follows: (1) the field layout of the upland areas of the project be approximately 200 m long at 1 in 500 gradient in the furrow direction; (2) furrows should have broad flat bases between ridges; (3) a lead stream of 2-2.3 l/sec should be adequate for furrows of 1-m spacing; and (4) an irrigation frequency of 4 days would be appropriate. (See also W91-02288) (Rochester-PTT) W01-02315

QUANTIFYING THE WATER BALANCE OF DRYLAND MILLET IN NIGER USING STATE OF THE ART EVAPORATION TECHNIQUES. Institute of Hydrology, Wallingford (England).
J. S. Wallace, J. H. C. Gash, D. D. McNeil, and
M. V. K. Sivakumar.

M. V. K. Sivakumar.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 352-360, 4 fig, 8 ref.

Descriptors: \*Data acquisition, \*Dry farming, \*Evaporation, \*Hydrologic budget, \*Measuring instruments, \*Niger, \*Semiarid lands, \*Soil-waterplant relationships, Evapotranspiration, HYDRA, Lysimeters, Millet, Performance evaluation, Porometers, Soil moisture meters, Soil water.

Water use on sparse dryland crops is an important aspect of the hydrology of semi-arid zones because it is closely linked with crop yield. Information on the energy and water balance of Sahelian land-scapes is needed to improve the accuracy of the output of global climate models that predict such phenomena as desertification. To improve the description of the energy balance and evaporation from sparse vegetation a collaborative project was undertaken between the Institute of Hydrology (IH), United Kingdom, and the ICRISAT Sahelian Center in Niger. The principal aim of the project was to make detailed measurements of plant, soil, and total evaporation in a sparse millet crop. Measwas to make detailed measurements of plant, soil, and total evaporation in a sparse millet crop. Measurement techniques included the use of state-of-the-art eddy correlation devices ('The HYDRA') developed at IH, porometry to measure transpiration, and the use of microlysimeters to measure soil evaporation. Some preliminary results are presented showing how the energy balance and evaporation changed after rainfall and how the components of the total evaporation varied widely with soil wetness. The Hydra was able to provide routine measurements of evaporation and sensible heat flux to an accuracy of around 10%. The porometry and lysimeter techniques showed good agreement with the Hydra results and permitted the separation of soil from plant evaporation. The results demonstrated clearly the importance of soil evaporation in the water balance of areas covered by sparse vegetation. (See also W91-02288) (Rochester-PTT) ter-PTT) W91-02316

UTILIZATION OF THE LAW OF GAPS FOR THE DESCRIPTION OF THE PLUVIOMETRIC REGIME (L'UTILISATION DE LA LOI DES FUITES POUR LA DESCRIPTION DES RE-GIMES PLUVIOMETRIQUES).

Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Niamey (Niger). Mission ORSTOM au Niger.

For primary bibliographic entry see Field 2B. W91-02345

Accra

USE OF RUN OFF ON CULTIVATED FIELDS IN THE SUDAN-SAHELIAN AREA: BURKINA FASO, YATENGA PROVINCE, BIDI REGION (VALORISATION AGRICOLE DES EAUX DE RUISSELLEMENT EN ZONE SOUDANO SAHELIENNE: BURKINA FASO, PROVINCE DU YATENGA, REGION DE BIDD.

Institut Français de Recherche Scientifique pour le Developpement en Cooperation, Ouagadougou (Burkina Faso). Centre ORSTOM a Ouagadougou.

J. Lamachere, and G. Serpantie.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of

#### WATER QUANTITY MANAGEMENT AND CONTROL—Field 4

#### Control Of Water On The Surface—Group 4A

Africa. Proceedings of the Sahel Forum, Ouaga-dougou, Burkina Faso, 18-23 February 1989. Inter-national Water Resources Association, Urbana, Il-linois. 1990. p 933-945, 7 fig. 2 tab, 6 ref. English

Descriptors: \*Agricultural water, \*Burkina Faso, \*Cultivated lands, \*Erosion control, \*Rainfall-runoff relationships, \*Runoff, \*Water harvesting, Crop yield, Millet, Performance evaluation, Plant growth, Seepage, Soil erosion, Soil moisture retention, Soil water.

In Yatenga Province, northern Burkina Faso, the cultivated plots often are located at a lower level than relatively impermeable areas. The runoff on these surfaces constitutes both a surface water resource for agriculture and erosive force attacking the fine sandy soils, which are very vulnerable to water erosion. To analyze the effect of a series of water erosion. To analyze the effect of a series of seeping obstructions over the plowed and unplowed plots on which millet grows, three experimental plots were established near the village of Bidi in northern Yatenga. Rainfall, runoff, soil humidity, and agricultural production data were observed for 3 yr (1985, 1986, 1987). The runoff analysis shows the effect of the state of the soil surface and of the moisture content. Stone ribbons reserves effective during beauty reiner. They in are more effective during heavy rains. They increase by 20% the amount of runoff absorbed, reduce the flow, and prolong its period. This effect of stone ribbons on the hydrographs suggests that of stone ribbons on the hydrographs suggests that this improvement contributes to protection against soil erosion. During flow periods, the stone belts encourage the replenishment of the water resources of soil having good retention capacity. The millet experiences a reduction in water deprivation periods and benefits from a better use of soil mineral resources. During the 3-yr period an increase in dry matter was noted on the improved parcel. The increase in dry seed return, although very irregular, was about 40%. (See also W91-02288) (Author's abstract) thor's abstract) W91-02365

TAPPING OF WATER HOLES FROM TEMPORARY SURFACES TO IMPROVE SAHELIAN PASTURELAND MANAGEMENT (EXPLOITATION DE POINTS D'EAU DE SURFACE TEMPORAIRES POUR L'AMELIORATION DE LA GESTION DES PATURAGES SAHELIENS). Office de la Recherche Scientifique et Technique Outre-Mer, Montpellier (France). Lab. d'Hydrolo-

gie.
For primary bibliographic entry see Field 3B.
W91-02366

WATER ASSESSMENT OF SOILS AND TRADI-TIONAL AGRICULTURAL CALENDARS IN UPPER BORGOU (REP. POP. DU BENIN) (BILANS D'EAU DES SOILS ET CALENDRIERS AGRICOLES TRADITIONNELS DANS LE HAUT BORGOU (R.P. BENIN). Universite Nationale du Benin, Cotonou. Dept. de Geographie

Geographie. M. Boko.

M. Boko.

IN: The State-of-the-Art of Hydrology and Hydrogoology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 957-963, 11 ref. English summary.

Descriptors: \*Arid lands, \*Benin, \*Rainfall, \*Soil water, Agricultural water, Evapotranspiration, Seasonal variation, Upper Borgou.

The Upper Borgou is part of the subsahelian area. It has a dry tropical climate but with little variability (15% over a long period). The annual rainfall is average (90 mm) with a high seasonal concentration. Consequently, farmers must sow after the first tion. Consequently, farmers must sow after the first important rainfall. There are two types of soils, important rainfall. There are two types of soils, alluvial and tropical ferruginous, very concretionary, with a useful water reserve varying between 120 and 180 mm. The potential evapotranspiration (PET) is very high between the end of the harmattan period and the beginning of the rainy season. The water assessments of soils calculated for an average year and for wet and dry years compared with agricultural calendars. As a result of this

comparison of the high variability of rainfall and the length of rainy seasons over the past 10 yr, farmers have adopted mobile agricultural calendars that begin with a useful water reserve approximately more than 50% of the total evapotranspiration. This empirical practice is based on the observation of depth of the moisture of soils and a very approximate evaluation of the quantities of rainfall. One question is whether it is risky that this estimation corresponds to a single measure of the recharge of the soil (50% of PET). This appears to be the result of the close knowledge farmers have of the hydrodynamic characteristics of the soils they cultivate. (See also W91-02288) (Rochester-PTT). PTT) W91-02367

# IDENTIFICATION AND INVENTORY OF PHILIPPINE FORESTED-WETLAND RE-

Philippines Dept. of Environment and Natural Resources, College. Coastal Zone and Freshwater Ecosystems Research Div. For primary bibliographic entry see Field 2H. W91-02473

MANGROVE FOREST RESOURCES IN INDO-

MANGROVE FOREST RESOURCES IN INDO-NESIA.

Louisiana State Univ., Baton Rouge. School of Forestry, Wildlife and Fisheries.

For primary bibliographic entry see Field 2H.

W91-02474

MANGROVES IN KAMPUCHEA. Humboldt State Univ., Arcata, CA. Dept. of Forest Economics. For primary bibliographic entry see Field 2H. W91-02475

INVENTORY AND MONITORING OF FOR-ESTED-WETLAND RESOURCES OF ASEAN. Pertanian Malaysia Univ., Serdang. Faculty of

For primary bibliographic entry see Field 2H. W91-02476

APPLICATION OF A DIGITAL GEOGRAPHIC DATA BASE TO IRRIGATION WATER RIGHTS MANAGEMENT.
Bureau of Reclamation, Denver, CO. Engineering

and Research Center.
For primary bibliographic entry see Field 6E.
W91-02598

AGRICULTURAL WATER USE MONITORING THROUGH LANDSAT SURVEILLANCE. Earth Technology Corp., Long Beach, CA.

Earth Technology Corp., Long Beach, CA.
IN: Remote Sensing Applications for Consumptive
Use (Evapotranspiration). Papers Presented at 21st
Annual AWRA Conference and Symposium,
August 11-16, 1985, Tucson, Arizona. AWRA
Monograph Series No. 6, (1985). p 65-72, 5 fig, 3

Descriptors: \*Agricultural water, \*Arizona, \*Consumptive use, \*Landsat images, \*Remote sensing, \*Satellite technology, Geographic information systems, Water resources management, Water rights.

Arizona's massive water consum paradox to its arid environment. Agriculture is the single greatest user of the limited water resources, single greatest user of the limited water resources, yet the extent of water use can be difficult to ascertain. However, agriculture is readily detectable through Landsat data analysis. A water rights geographic information system (GIS) when combined with satellite surveillance can assist in water rights determinations, water law enforcement and water use estimates. The combination of Landsat and GIS is becoming a more familiar approach to natural resource management techniques. The contemporary nature of satellite data can accommodate surveillance purposes or other new real-time assessments of resource conditions. By recombin-ing data sets and establishing Boolean relationships between Landsat and GIS data, a vast amount of

synthetic information can be visually and statistically captured. As with many GIS based natural resource management programs, many supplemental programs can be supported with data designed for an initial purpose. (See also W91-02594) (Lantz-PTT) W91-02600

ACCESS OF SMALL AND MARGINAL FARM-ERS TO GROUNDWATER-A FIELD STUDY. Roorkee Univ. (India). Water Resources Develop-ment Training Center. For primary bibliographic entry see Field 4B. W91.00575 W91-02675

GROUNDWATER MANAGEMENT BY A DUAL-PIPE SUBIRRIGATION SYSTEM. Iowa State Univ., Ames. Astronomy Program. For primary bibliographic entry see Field 4B. W91-02677

#### 4. WATER QUANTITY MANAGEMENT AND CONTROL

#### 4A. Control Of Water On The Surface

INFLUENCE OF THE HERBICIDE PARA-QUAT 'GRAMAXON' ON GROWTH AND METABOLIC ACTIVITY OF THREE CHLORO-

HYTLES.
Institute of Oceanography and Fisheries, Cairo (Egypt). Lab. of Aquatic Plants.
E. A. Ibrahim.
Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 1/2, p 89-93, May 1990. 1 fig, 21 ref.

Descriptors: \*Algae, \*Aquatic weed control, \*Chlorophyta, \*Herbicides, \*Metabolism, \*Paraquat, \*Plant growth, Bioassay, Chlorophyll a.

The acute toxicity of the commercial herbicide, paraquat, commonly used in the control of aquatic weeds, was determined by 96 hour static bioassay weeds, was determined by 96 hour static bioassay on the freshwater chlorophytes Scenedesmus dimorphus, Scenedesmus quadricauda and Ankistrodesmus falcatus. The 96 hour EC50 values of paraquat for reducing growth and metabolic products of the three algae were determined. The number of days required for cell division increased with increasing paraquat concentration. The three number of days required for cell division increased with increasing paraquat concentration. The three algae and their test parameters respond differently to paraquat. Scenedesmus dimorphus was the most susceptible alga and the chlorophyll a was the most sensitive response parameter. On the other hand, the dry weight of the test algae was the most resistant parameter. The effective dose for controlling macrophytes is I mg/L. The results show that application of paraquat causes an inhibitory effect in primary producers. (Author's abstract) W91-02085

POTENTIAL HAZARDS FROM FLOOD-FLOWS IN GRAPEVINE CANYON, DEATH VALLEY NATIONAL MONUMENT, CALIFOR-NIA AND NEVADA.

Geological Survey, Sacramento, CA. Water Resources Div For primary bibliographic entry see Field 2E. W91-02230

IMPROVED METHODS FOR REGIONAL FLOOD FREQUENCY ANALYSIS. Colorado State Univ., Fort Collins. Dept. of Civil

For primary bibliographic entry see Field 2E. W91-02243

FLOODS OF FEBRUARY 1989 IN TENNESSEE. Geological Survey, Nashville, TN. Water Resources Div. F. Quinones, and C. R. Gamble.

#### Field 4-WATER QUANTITY MANAGEMENT AND CONTROL

#### Group 4A-Control Of Water On The Surface

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4207, 1990. 15p, 6 fig. 4 tab, 3 ref.

Descriptors: \*Flood recurrence interval, \*Floods, \*Rainfall, \*Storm runoff, \*Tennessee, Flooding, Peak discharge, Streamflow.

Rainfall amounts of over 5 inches the night of February 13 and the morning of February 14, 1989, caused flooding in areas of Middle and West Tennessee. The towns of Lebanon in Middle Tennessee and Obion in West Tennessee were most severely affected. Most of the business district in severely affected. Most of the business district in Lebanon and many residential areas in Obion were flooded. Recurrence intervals for 24-hour rainfall totals were as high as 25 years at some sites but totals were as mign as 25 years at some sites but most peak discharges had recurrence intervals of less than 10 years. Rainfall amounts for the period February 13-20, 1989, peak stages and discharges for this flood, the peak of record, and a list of discharge measurements made during the flood are documented. (USGS) documente W91-02260

IMPACT OF WATER CONTROL ON NAVAJO IRRIGATION PROJECTS. Colorado State Univ., Fort Collins. Dept. of Civil

For primary bibliographic entry see Field 3F. W91-02278

HYDRAULIC WORKING OF SHALLOW WATERS IN WEST AFRICA (FONCTIONNE-MENT HYDROLOGIQUE DES BAS FONDS EN AFRIQUE DE L'OUEST).

Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Dakar (Senegal). Centre de Dakar.

Centre de Dakar.

J. Albergel, and J. Claude.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouaga-dougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 330-342, 4 fig, 16 ref. English sum-

Descriptors: \*Agriculture, \*Flood plain management, \*Floods, \*Land use, \*Water resources development, \*West Africa, Acidic soils, Casamance, Developing countries, Gambia, Guinea, Sahel, Saline soils, Sudan.

From the northern border of the Sahel to the forested areas in the south of Guinea, wet areas in Africa are being cultivated increasingly. The development of farming in the river beds is linked to constraints on rain farming on the slopes, drought in the north, exhaustion and erosion of the soil, or a shortage of arable land on the slopes in the areas with a more favorable climate. In the Sahel and the with a more favorable climate. In the Sahel and the Sahelo-Sudan, drainage areas are usually spread out, rarely confined. Floods are sudden and large, and drainage in submerged areas often is slowed by topographical thresholds downstream. Temporary flooding feeds inter-flux expanses of water in the depressions. The relatively wooded flood plains are used as secondary pasture by shepherds in the north, whereas further south this is rivaled by agriculture (e.g., gardens and small rice fields). In the Sudano-Guinean region, the flood plains are affected by the rise or lateral flow from the expanses in depressions and the convergence of surface streams. Where the river bed has been transformed by human intervention, cash crops such as rice, by human intervention, cash crops such as rice, cotton, and maize often are grown. The flood plains along tidal reaches of Gambia and Casamance and in coastal Guinea are the home of important development programs. These improve-ments should solve problems of acidification and salinity of the soil. (See also W91-02288) (Author's abstract) W91-02314

WATER RESOURCES MANAGEMENT IN NI-GERIA: THE RIVER BASIN APPROACH. Ibadan Univ. (Nigeria). Dept. of Geography.

A. Faniran.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 836-845, 4 fig, 1 tab, 13 ref.

Descriptors: \*Dams, \*Nigeria, \*River basin development, \*Water resources development, Agriculture, Industry, Management planning, Monitoring, Reservoirs, Storage reservoirs, Water supply.

Nigeria's water resources are currently being deraigera's water resources are currently being developed for many purposes, including domestic, agricultural, and industrial uses. Irrigation activities in the north of the country have been widely reported, but more recent activities by river basin development authorities have not been so reported. development authorities have not been so reported. Projects of the Upper Benue River Basin Authorities in the Gongola Basin (Kuri, Dadi Kowa, and Cham projects) are highlighted. Each river basin authority is currently engaged in 2-3 large-scale projects and numerous small-scale projects (earth dams, wells, boreholes, channel improvements, etc.). The Dadi Kowa scheme has the second largest storage, after Kainji Dam, in Nigeria. The Cham earth dam is one of many small-scale dams the authority has either constructed or proposed for construction. With persistent and well-guided for construction. With persistent and well-guided efforts, the nation's water resources shortly will be fully controlled and ready to best serve the needs of the population. In the future, river basin authorities will need to be strengthened, both materially and in personnel, to perform other functions within the river systems, such as development of an efficient data management system and, perhaps more importantly, comprehensive planning, execution, and monitoring of the environmental impacts of development projects, as well as the observation and recording of natural processes. (See also W91-02288) (Rochester-PTT) W91-02357

HYDROLOGY AND RIVER CONTROL ON THE NIGER AND SENEGAL.
Gibb (Alexander) and Partners Ltd., Reading

For primary bibliographic entry see Field 2E. W91-02358

SYSTEMS ENGINEERING APPROACH TO SO-LUTIONS OF DROUGHT IN DEVELOPING COUNTRIES: THE CASE OF TANZANIA.

New Tech International Inst., Dar es Salaam (Tanzania).
For primary bibliographic entry see Field 2A.
W91-02361

POSSIBILITIES FOR REGENERATION OF FLOODPLAIN FORESTS WITHIN THE FRAMEWORK OF THE FLOOD-PROTECTION MEASURES ON THE UPPER RHINE, WEST

Institute for Floodplains Ecology, Rastatt (Germa-

ny, F.R.). A. Zinke, and K. A. Gutzweiler.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 13-20, June 1990. 3 fig. 5 ref.

Descriptors: "Flood plain forests, "Flood plain management, "Forest management, "Germany, "Reforestation, "Regeneration, "Rhine River, "Soil-water-plant relationships, "Water resources management, Flood control, Flood plains, Forest watersheds, France, Management planning, Pol-ders, Revegetation, Weirs.

The Upper Rhine valley in Germany is one of the most densely populated areas in Europe. As a result, human interference has significantly reduced both the original species diversity as well as the ecological function of the floodplain forests in the area. Furthermore, past mismanagement and potential flood danger necessitates the adoption of new management policies concerning this type of landscape. Among these measures, Germany and France have planned extensive specialized flood-protection strategies including the construction of polders and the utilization of weirs. In addition, the

Institute for Floodplains Ecology has proposed the relocation of existing dams which would achieve a much more effective flood practice. It is concluded that with proper future planning and well-selected flood-protection procedures, the floodplain forests could potentially be regenerated. (D'Agostino-PTT) W91-02472

POTENTIAL FOR ENHANCING RIPARIAN HABITATS IN THE SOUTHWESTERN UNITED STATES WITH WATERSHED PRAC-

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab. L. F. Debano, and L. J. Schmidt.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 385-403, June 1990. 3 fig, 40 ref.

Descriptors: \*Flow control, \*Forest ecosystems, \*Land management, \*Riparian vegetation, \*Riparian waters, \*Streamflow, \*Streams, \*Watershed management, Channelization, Ephemeral streams, Hydrology, Stream discharge, Stream improve

Riparian communities are unique and sensitive habitats that are strongly interrelated with the surrounding watershed. Currently, since previous misuse has led to their extensive degradation, management of riparian areas is a critical issue in the southwestern United States. Potential opportunities for better management of existing ecosystems or for the re-establishment of new riparian communities generally exist where either the amount of water or the duration of streamflow, or both, can nutes generally exist where either the amount of water or the duration of streamflow, or both, can be increased. Various-sized channel structures, ranging from small gully check dams to large flood control structures, have been used successfully for both stabilizing erodible channels and lengthening streamflow duration. Such channel structures trap sediment in upstream deposits which store water, sediment in upstream deposits which store water, and release it slowly over time, thereby producing perennial flow in previously ephemeral streams. In addition, the deposited sediment also provides a nutrient-rich medium which further favors plant establishment and growth. The amount and duration of streamflow through a riparian zone can also eincreased by manipulating upslope vegetation where deep-rooted plants are replaced with more shallow-rooted species using less water. Such watershed practices may potentially improve the hydologic conditions in southwestern streams as well as enhance establishment of riparian vegetation. (D'Agostino-PTT)

ENVIRONMENTAL RIVER ENGINEERING.

University of East Anglia, Norwich (England). School of Environmental Sciences.

School of Edwards.

R. D. Hey.

Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 4, p 335-340, August 1990. 4 fig, 17 ref.

Descriptors: \*Channel flow, \*Hydraulic engineering, \*Regulated flow, \*River channels, Canals, Channels, Flood control, Geomorphology, River echanics, River systems

River engineering works have often caused channel instability and adversely affected the river's conservation and amenity value. Recent guidelines have advocated a more natural approach to river engineering practice, to retain a habitat diversity within the river system. While a more natural approach is desirable, a geomorphological guidance is required to ensure that the advocated changes are feasible and sustainable, both in the long and short term. The key requirement for sound environmental river engineering is a basic understanding of the natural processes controlling channel shape and dimensions. Examples are given in the paper to illustrate how such knowledge can be used to: (1) stabilize rivers, (2) design environmentally acceptable and stable flood alleviation schemes, and (3) restore previously canalized rivers. The basis of the geomorphological input in the assessment and design process is a river survey which determines the factors controlling channel

#### WATER QUANTITY MANAGEMENT AND CONTROL—Field 4

#### Groundwater Management—Group 4B

characteristics and how it will respond to planned changes. (Author's abstract) W91-02845

CLIMATIC INFLUENCES ON STREAMFLOW VARIABILITY: A COMPARISON BETWEEN SOUTHEASTERN AUSTRALIA AND SOUTH-EASTERN UNITED STATES OF AMERICA. Melbourne Univ., Parkville (Australia). Dept. of Civil and Agricultural Engineering. For primary bibliographic entry see Field 2B. W91-02877

#### 4B. Groundwater Management

ALTITUDE OF POTENTIOMETRIC SURFACE, FALL 1985, AND HISTORIC WATER-LEVEL CHANGES IN THE MEMPHIS AQUIFER IN WESTERN TENNESSEE.

Geological Survey, Nashville, TN. Water Resources Div

For primary bibliographic entry see Field 2F. W91-02224

GEOLOGY AND GROUND-WATER RE-SOURCES OF THE COCKFIELD FORMATION IN WESTERN TENNESSEE.

Geological Survey, Nashville, TN. Water Resources Div For primary bibliographic entry see Field 2F. W91-02225

SELECTED GROUND-WATER INFORMATION FOR THE PASCO BASIN AND ADJACENT AREAS, WASHINGTON, 1986-1989. Geological Survey, Tacoma, WA. Water Re-For primary bibliographic entry see Field 2F. W91-02233

IMPROVED YIELD OF RURAL WATER WORKS THROUGH HYDRAULIC FRACTUR-ING EXPERIMENTS (AMELIORATION DE LA PRODUCTIVITE DES OUVRAGES D'HYDRAULIQUE YILLAGEOISE PAR FRACTURALION HYDRAULIQUE EXPERIMENTATION).

TION HYDRAULIQUE EXPERIMENTATION). Bureau de Recherches Geologiques et Minieres, Orleans (France). Water Resources Dept. M. Bonnet, H. Etienne, and P. Vaubourg. IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 562-573, 7 fig, 2 tab, 5 ref. English summary.

Descriptors: \*Geologic fractures, \*Groundwater availability, \*Hydraulic fracturing, \*Rural areas, \*Water yield improvement, \*Well yield, Bore-holes, Brittany, France, Semiarid lands.

Statistical analysis of the discharge values for thou-Statistical analysis of the discarage values for mou-sands of boreholes drilled in basement complex formations shows that about 30% of the wells have a productivity of less than 1 cu m/hr and 15% only have 5 cu m/hr or more. Based on most of the projects, three features were apparent: (1) in a homogeneous hydrogeologic and climatic context, similarly-sited wells have varied results; (2) the similarly-sited wells have varied results; (2) the most significant yields are produced by several fractures generally crossed at a depth of 50 m; and (3) the 'dry' or very poorly producing wells reached no large fractures or only fractures clogged or closed by the pressure of the ground. The hydraulic fracturing technique was inspired by the idea that increased output could be obtained by artificially enhancing the hydraulic connections between the borehole and the more productive natural surrounding fracture network. The hydraulic fracturing consists of isolating a borehole section with packers and injecting water at a pressure higher than the natural constraints at the investition with packers and injecting water at a pressure higher than the natural constraints at the investi-gated depth. Generally, breaking or bursting occurs, which opens up fissures. The injected water is charged with sand, which penetrates into the fissures and remains there after pressure re-

lease, thus keeping the fissures open. The first rease, thus keeping the insures open. The first the experiment was conducted on eight boreholes in the south of the crystalline massif of Brittany (France). The productivity of the wells was increased by at least 13%; on four of them, it increased by 50%. A similar experiment will be conducted on 25 boreholes drilled in the basement conducted on 25 boreholes drilled in the basement complex of Burkina Faso, with two objectives: (1) recovery of boreholes with productivities of less than 1 cu m/hr for village water supply and (2) increase in low-discharge wells (1-3 cu m/hr) to make possible small-scale irrigation and mini rural domestic water supplies. (See also W91-02288) (Author's abstract) W91-02335

STATE OF THE ART HYDROLOGY FOR THE DEVELOPMENT OF SAHELIAN WATER RE-

Ohio Univ., Athens. Dept. of Hydrogeology. For primary bibliographic entry see Field 2F. W91-02355

#### ARTIFICIAL RECHARGE IN THE ANGAS-BREMER IRRIGATION AREA.

S. R. Howles Mines and Energy Review South Australia, No. 157, p 22-28, 1990. 17 fig, 3 tab, 19 ref, append.

\*Artificial recharge, Descriptors: L'escriptors: "Artificial recharge, "Confined aquifers, "Groundwater management, "Irrigation effects, "Saline groundwater, Angas River, Aquifers, Australia, Bremer River, Drawdown, Groundwater recharge, Recharge wells, Saline water intrusion. Salinity

Overdevelopment of the confined limestone aquifer underlying the Angas-Bremer irrigation area in South Australia has caused severe salinity prob-South Australia has caused severe salinity prob-lems. Annual water extraction in recent years has been about 16,000 ML, which has created a signifi-cant regional drawdown. This extraction has alos allowed saline waters to infiltrate from marginal areas of the groundwater basin, and induced the recirculation of irrigation water. Natural recharge is estimated to be only 25% of extraction. Artificial recharge wells are being used increasingly by irri-gators to replenish the aquifer with flood waters having 500-1,500 mg/L total dissolved solids. In many places this has halved the ambient ground-water salinity. South Australia Department of many places this has narved the amoient ground-water salinity. South Australia Department of Mines and Energy has developed an experimental recharge well in the area to assist irrigators in overcoming design problems with their own wells. (Author's abstract) W91-02530

### GROUNDWATER MANAGEMENT: QUANTI-

GROUNDWATER MANAGEMENT: QUANTI-TY AND QUALITY.
Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. 633p. Edited by A. Sahuquillo, J. Andreu, and T. O'Donnell.

Descriptors: \*Aquifer management, \*Groundwater management, \*Symposium, \*Water pollution control, \*Water quality management, \*Water resources management, Case studies, Decision making, Groundwater movement, Groundwater quality, Hydrologic models, Management planning, Model studies, Research priorities, Water quality control, Watershed management.

Increasing water needs, constraints imposed by quality for different uses, and the growing impor-tance of contamination as a result of urban, industance of contamination as a result of urban, industrial, and agricultural activities make it more and more necessary to consider aquifers as components of water resources systems to increase dependable water supplies and to preserve water quality. In order to obtain gains in efficiency, it is necessary to understand the flow and chemical processes involved in groundwater and to develop management models to simulate and optimize both quantity and quality. A symposium held in Spain 2-5 October 1989 contributed 53 papers from many different countries, addressing the following topics: the role of groundwater quantity in the decision-making process on water resources, the role of

groundwater quality in the decision-making process in water resources, models for groundwater management, aquifers as components of water re-sources systems, and applications and case studies. sources systems, and applications and case studies. These papers represent an important contribution that addresses groundwater management problems in their two crucial aspects of groundwater quantity and quality, and gives an excellent idea of the state of the art and of the direction this subject will take in the near future. (See W91-02673 thru W91-02724) (Fish-PTT)

ACCESS OF SMALL AND MARGINAL FARM-ROOTE UT SWALL AND MARGINAL FARM-ERS TO GROUNDWATER-A FIELD STUDY. Roorkee Univ. (India). Water Resources Develop-ment Training Center.

A. S. Chawla, C. S. Raghuvanshi, and S. A.

Numar.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 29-40, 9 tab.

Descriptors: \*Agricultural water, \*Farming, \*Groundwater management, \*India, \*Irrigation water, \*Supplemental irrigation, \*Water resources development, Canals, Crop production, Cultiva-tion, Economic evaluation, Horizontal wells, Pumping, Wells.

The importance of groundwater and its development has been greatly felt in India during the last few decades. Groundwater alone accounts for about 40% of the total irrigated area in the country. The most outstanding problem is that of raising the economic and social status of millions of marginal and small farmers. A large number of tubewells has been installed in alluvial areas to pump groundwater to supplement canal supplies in canal-commanded areas and to provide irrigation water outside the canal command areas. The accessibility of small and marginal farmers to groundwater was examined in western Uttar Pradesh, India, including an evaluation of the economics of various lifting devices, the water requirement of India, including an evaluation of the economics of various lifting devices, the water requirement of crops and the capacity of wells for different categories of farmers. An analysis of the data indicates that the small and marginal farmers constituting 62% of the sample farmers operate only 23.4% of cultivable land and own only 31% of private tubewells. Only 43% of these farmers have access to groundwater. Electrically operated tubewells are most economical. Small and marginal farmers should have a pumping capacity of 3.5-5.0 HP. (See also W91-02672) (Author's abstract) W91-02675

### GROUNDWATER MANAGEMENT BY A DUAL-PIPE SUBIRRIGATION SYSTEM.

Iowa State Univ., Ames, Astronomy Program, D. Kirkham, and R. Horton.

D. Kirknam, and K. Horton.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 53-66, 5 fig, 1 tab, 13 ref.

Descriptors: \*Drainage engineering, \*Groundwater irrigation, \*Groundwater management, \*Irrigation design, \*Model studies, \*Subirrigation, \*Water resources management, Boundary conditions, Evapotranspiration, Groundwater movement, Hydraulic conductivity, Hydraulic models, Laplace equation, Pipes, Saturation zone, Velocity head, Water table profiles.

Solutions to water flow problems form practical relationships useful to groundwater management. Determination of hydrological quantities for a dual-pipe subirrigation-drainage system has already been done where rectangular (shi) tubes were used. An analytical solution of Laplace's equation has been developed for appropriate boundary con-ditions associated with the problem of dual-pipe subirrigation and drainage extended to cylindrical tubes. The solution describes stream function and hydraulic head within the groundwater flow region and likewise the associated water table

#### Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

#### **Group 4B—Groundwater Management**

shape. The solution is general and flexible. Response of the groundwater system can be studied relative to thickness of saturated zone, position of relative to thickness of saturated zone, position of subirrigation and drainage pipes, crop evapotran-spiration, fraction of inflowing subirrigation water that exits the drains, and the aquifer hydraulic conductivity. Calculations show how pipe spacing affects shape of water table. The general solution can also be used also to predict salt flow through the system as well as water flow. (See also W91-02672) (Author's abstract) W91-02677

DISTRIBUTION OF AQUIFER RECHARGE FROM A CIRCULAR SPREADING BASIN UNDER TRANSIENT OPERATIONS.

Colorado State Univ., Fort Collins. Dept. of Civil Engineering. H. J. Morel-Seytoux, C. Miracapillo, and M. J.

H.J. Moret-Seytoux, C. Milacapino, and M. Abdulrazzak.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 67-76, 5 fig, 6 ref.

Descriptors: \*Aquifer characteristics, \*Aquifer management, \*Artificial recharge, \*Flow models, \*Groundwater management, \*Model studies, \*Water resources management, Groundwater basins, Groundwater movement, Groundwater recharge, Infiltration rate, Mathematical models, Numerical analysis, Recharge basins, Saturation zone, Three-dimensional model, Watershed management.

The process of aquifer recharge from a circular area has been investigated for management purposes. An approximate solution to the three-dimensional problem was obtained by matching two unidimensional flows, a vertical and a radial one. The mathematical formulation was obtained first for the case of a constant infiltration rate and then for a time-dependent rate through the unsaturated zone. The formulation led to an integro-differential equation whose solution was obtained numerically. In both cases, concrete examples illustrated the influence of the parameters on the discharge into influence of the parameters on the discharge into the saturated zone and on the water table level. It was determined that anisotropy of the medium influences the mound elevation below the recharge zone and to a lesser degree the discharge. Numerical examples showed that the effect of a lower horizontal conductivity is partially compensated by a higher hydraulic head, due to a more rapid rise of the water table below the spreading basin. The lateral recharge efficiencies permit compari-sons between different geometric designs. Between sons between different geometric designs, between are arectangular and a circular basin having the same area and the same spreading perimeter the efficiency of the linear geometry is higher. The model can be used also to compare different operational schemes. (See also W91-02672) (Fish-PTT) W91-02678

APPLICATION OF THE ANALYTIC ELE-MENT METHOD FOR NATIONAL GROUND-WATER MANAGEMENT IN THE NETHER-

Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
For primary bibliographic entry see Field 6A.
W91-02697

MANAGEMENT MODEL FOR AQUIFER RE-CHARGE WITH NON-CONSERVATIVE POL-

LUTANTS.
Baghdad Univ. (Iraq). Coll. of Engineering.
Q. N. Fattah, and H. M. Hamad.
IN: Groundwater Management: Quantity and
Quality. Proceedings of the Symposium held at
Benidorm, Spain, October 2-9, 1989. International
Association of Hydrological Sciences, Washington, DC. 1989. p 295-304, 10 fig., 4 ref.

Descriptors: \*Groundwater management, \*Hydrologic models, \*Model studies, \*Recharge, \*Water quality management, \*Water resources management, Confined aquifers, Convection, Dispersion, Groundwater pollution, Groundwater recharge, Hydrological models, Parametric hydrology, Par-

tially penetrating wells, Path of pollutants, Plumes, Pollutant identification.

The management of aquifer recharge in conformity with particular environmental standards requires that contaminant concentration zones be identified Theoretical solutions to the convective-dispersion neceptation solutions to the convective-dispersion equation have been examined for a substance injected by a partially-penetrating well into a confined isotropic homogeneous aquifer. A numerical solution for the concentration distribution of the substance in the aquifer was developed using an alternating-direction implicit method. The model was designed for conservative and non-conserva-tive substances, and for different influent concentration distribution. A management model was de-veloped combining the influent temporal concentration distribution with partial penetration ratios and extent of polluted zone in the aquifer. Various and extent of polluted zone in the adulter. Various combinations of these parameters may be attempted in order to develop the appropriate concentration distribution for a given pollutant, thus enabling the engineer to perform recharge operations in accordance with environmental standards. (See also W91-02672) (Fish-PTT)

MODELING OF VARIABLE DENSITY FLOW, APPLICATION TO THE MANAGEMENT OF COASTAL AQUIFERS (MODELISATION DES ECOULEMENTS A DENSITE VARIABLE, AP-PLICATION A L'EXPLOITATION DES AQUI-FERES COTIERS).

Bureau de Recherches Geologiques et Minieres, Orleans (France).
For primary bibliographic entry see Field 2F.
W91-02706

MODELLING OF FLOW AND CONTAMI-NANT TRANSPORT IN A CONJUNCTIVELY MANAGED GROUNDWATER BASIN: A CASE

California Univ., Davis. Dept. of Agricultural Economics.

For primary bibliographic entry see Field 5B. W91-02707

AQUIFERS AS COMPONENTS OF WATER RESOURCES SYSTEMS.

TAHAL-Water Planning for Israel Ltd., Tel-Aviv. J. Schwarz.

J. Schwarz.
IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 433-441, 11 ref.

Descriptors: \*Aquifer management, \*Groundwater management, \*Groundwater resources, \*Planning, \*Water resources management, \*Water supply de-velopment, Aquifer characteristics, Artificial recharge, Conjunctive use, Legal aspects, Management planning, Water quality management, Water

Aquifers function within water resources systems as water sources, media of storage, and means of water quality upgrading. The role of an aquifer depends on the properties of the aquifer itself and on the properties of the system as a whole. Coninctive use of surface water and groundwater, and artificial recharge, are the most widespread uses of aquifers as components of water resources systems. Planning techniques are available to test management plans against a set of criteria includ-ing conservation of the resource and its environment, economic efficiency and financial viability. Knowledge gaps in the planning techniques and in Knowledge gaps in the planning techniques and in aquifer properties fall into two main categories: (1) properties of the soil-aquifer system, of the water supply system and of the socio-economic system; and (2) techniques for evaluation of management plans in three systems. The objectives of future research and development should include regenerative small-farm agriculture; definitions of safe yield; remedial measures to improve quality by chemical processes such as demineralization, biological in situ treatment or mixing with important logical in situ treatment, or mixing with imported low salinity water; long distance transport of high quality water; and development of water uses that

are tolerant. Emphasis will be placed in the future on conservation, regeneration, and remedial measures. (See also W91-02672) (Author's abstract) (Fish-PTT) W91\_02709

WASTE WATER, INFILTRATION-PERCOLA-TION FOR AQUIFER RECHARGE OR WATER

Montpellier-2 Univ. (France). Lab. d'Hydrologie et de Modelisation. For primary bibliographic entry see Field 5D. W91-02710

REGIONALIZATION SCHEMES FOR THE MANAGEMENT OF LARGE WATER RESOURCES SYSTEMS.

Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de aminos, Canales y Puertos

Caminos, Canales y Fuertos.

J. Carrera, L. Vives, and J. Heredia.

IN: Groundwater Management: Quantity and
Quality. Proceedings of the Symposium held at
Benidorm, Spain, October 2-9, 1989. International
Association of Hydrological Sciences, Washington, DC. 1989. p 457-470, 4 fig, 2 tab, 14 ref.

Descriptors: \*Aquifer management, \*Groundwater management, \*Groundwater resources, \*Large watersheds, \*Management planning, \*Planning, \*Regional planning, \*Water resources management, \*Water supply development, Computer models, Conjunctive use, Reservoirs, Simulation analysis, Surface-groundwater relations, Water demand.

The large size of some water resources systems may make classical management simulation meth-ods unrealistic or unaffordably expensive for those ods unrealistic or unaffordably expensive for those systems. This is particularly true in the case of strongly interacting surface water and groundwater and when a large number of demands are supplied by a large number of water sources (reservoirs and aquifers). Most management schemes either ignore the topology of the distribution network, thus leading to unrealistic simulations, or else consider an extremely large number of combinations, thus becoming unaffordably expensive. The concept of demand region, which takes into account both network geometry and water availaccount both network geometry and water availability, overcomes these limitations. Coupling this concept with a powerfully innovative method to incorporate aquifer-river interaction has led to a robust approach for the conjunctive use of large systems. (See also W91-02672) (Author's abstract) systems. (So W91-02711

HARVEST OF EPHEMERAL RUNOFF FOR ARTIFICIAL GROUNDWATER RECHARGE: FEASIBILITY EVALUATION USING HYDRO-LOGICAL AND HYDROGEOCHEMICAL

Nevada Univ. System, Las Vegas. Water Resources Center. For primary bibliographic entry see Field 3B. W91-02712

GROUNDWATER MANAGEMENT STRATEGY FOR SALINITY MITIGATION IN THE VICTO-RIAN RIVERINE PLAIN, AUSTRALIA. Rural Water Commission of Victoria, Armidale

For primary bibliographic entry see Field 3C. W91-02713

ROLE OF GROUNDWATER IN ISRAEL'S IN-

TEGRATED WATER SYSTEM.
TAHAL-Water Planning for Israel Ltd., Tel-Aviv. D. Hamberg.

D. Hamberg.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 501-514, 9 fig, 2 tab.

Descriptors: \*Aquifer management, \*Groundwater management, \*Groundwater resources, \*Israel,

#### Groundwater Management-Group 4B

\*Management planning, \*Model studies, \*Operat-ing policies, \*Planning, \*Water resources manage-ment, \*Water supply development, Drinking water, Finite difference methods, Groundwater potential, Groundwater recharge, Groundwater storage, Hydrologic models, Irrigation water, Re-habilitation, Saline water intrusion, Water demand.

Israel's national water system integrates water pumped from Lake Kinneret with two groundwater sources—the Karstic Aquifer and the Coastal Aquifer-supplying drinking water and irrigation water. In the rainy season irrigation demand drops water. In the rainy season irrigation cemand drops and the surplus system capacity is used for aquifer recharge. Various multi-annual simulation techniques were used to plan an operating policy that would guarantee high reliability. The operating policy derived was based on decreasing the quantipolicy derived was based on decreasing the quantities supplied below the average potential of the sources, thus creating reserve storage in the aquifers. The Coastal Aquifer is today overexploited, which has led to seawater intrusion, salination of the fresh water table. A rehabilitation program was planned by a schematic model that represents the aquifer as one 'black box.' The model was checked and detailed by a finite differences model of the aquifer. These tools are part of a hierarchic set of models and techniques used to build a new master plan for the water system of Israel. (See also W91-02672) (Author's abstract) W91-02712 (Author's abstract) W91-02714

MODELS FOR A RATIONAL UTILIZATION OF HIGH QUALITY GROUNDWATER RE-

SOURCES.
Dortmund Univ. (Germany, F.R.). Inst. for Environmental Protection. For primary bibliographic entry see Field 3E. W91-02715

ARTIFICIAL RECHARGE PILOT PROJECTS IN GUJARAT, INDIA.
Birmingham Univ. (England). Dept. of Civil Engi-

Birmingham Univ. (Engiano). Dept. of neering.
K. R. Rushton, and P. N. Phadtare.
IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 533-545, 5 fig, 1 tab, 6 ref.

Descriptors: \*Aquifer management, \*Artificial re-charge, \*Groundwater management, \*Groundwat-er resources, \*India, \*Irrigation effects, \*Water resources management, \*Water supply develop-ment, Alluvial aquifers, Alternative planning, Aq-uifer characteristics, Economic aspects, Ground-water depletion, Groundwater level, Groundwater recharge, Injection wells, Irrigation water, Lime-stone, Saline water intrusion.

Intensive exploitation of an aquifer frequently leads to deteriorating conditions, especially in highly progressive agricultural areas where the quantity of water withdrawn for irrigation nurnoses is usuof water withdrawn for irrigation purposes is usu-ally several times the recharge. This over-exploitaany several mines the techniques. This over-exploitation can lead to declining water levels, severe falls in pumping levels, and ingress of poor quality water. Artificial recharge is a possible means of alleviating the over-exploitation of aquifers, since it provides storage space free of cost, avoids evapo-ration losses and allows the use of the stored water during dry periods. Artificial recharge experiments in both alluvial and limestone aquifers in Gujarat, in both alluvial and limestone aquifers in Gujarat, India, were performed using spreading channels, percolation tanks, and injection wells. It was demonstrated that the first step in promoting an artificial recharge scheme is to perform experiments which can lead to an understanding of conditions in the aquifer system. These pilots schemes provide information about the physical conditions in the aquifer and also indicate the economic and management aspects which need to be considered. The aquiter and also indicate the economic and management aspects which need to be considered. The projects in Gujarat showed that artificial recharge is technically feasible using a number of alternative structures but the results also indicated that the effects of overexploitation and saline intrusion which have occurred due to beauty incinction. which have occurred due to heavy irrigation de-mands cannot be overcome solely by artificial re-charge. (See also W91-02672) (Fish-PTT)

W91-02717

MADRID MIOCENE AQUIFER AS A COMPONENT OF THE METROPOLITAN WATER SUPPLY SYSTEM.

MOPU, Madrid (Spain). Servicio Geologico. A. Sanchez, and M. Varela.

A. Sanchez, and M. Varela. In: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washing-ton, DC. 1989. p 547-556, 5 fig, 1 tab, 4 ref.

Descriptors: \*Aquifer management, \*Groundwater management, \*Groundwater resources, \*Madrid, \*Metropolitan water management, \*Model studies, \*Water resources management, \*Water supply development, Economic aspects, Operating policies, Pumping, Simulation analysis, Spain, Water demand, Water distribution.

The optimal operation scheme of the Madrid (Spain) aquifer has been analyzed from an economic point of view. A simulation model, including the whole system, reservoirs and aquifer, as well as the restrictions associated with the distribution network and some of the treatment plants, was con-structed for the analysis. The results of the modelstructed for the analysis. The results of the modeling efforts show that there are no significant differences, in economic terms, among various aquifer operation schemes. Nevertheless, a strategy based on intermittent high pumping rates is recommended; this would enable a more efficient utilization of an eventual groundwater concession and, at the same time, would provide the means to satisfy demand increases greater than those obtainable through any other operation rule. (See also W91-02672) (Author's abstract)

APPLICATION OF GROUNDWATER MODEL-LING IN WATER RESOURCES MANAGE-MENT IN DENMARK.

Miljoestyrelsen, Copenhagen (Denmark). For primary bibliographic entry see Field 5B. W91-02719

FEASIBILITY STUDY ON THE GROUNDWAT-ER DEVELOPMENT FOR THE WATER SUPPLY OF AN OIL SHALE PROCESSING PLANT IN CENTRAL JORDAN.

Bundesanstalt fuer Geowissenschaften und Roh-Bundesanstatt ruer Geowissenschaften und Restoffe, Hanover (Germany, F.R.).
H. Bender, W. Giesel, H. Klinge, R. M. Knoop, and K. Schelkes.

and R. Schelkes.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 571-579, 4 fig, 3 ref.

Descriptors: "Aquifer management, "Case studies, "Economic aspects, "Groundwater management, "Groundwater potential," "Groundwater resources, "Jordan, "Water resources management, Drilling, Geohydrology, Groundwater recharge, Model studies, Numerical analysis, Oil industry, Oil shale, Pumping, Water demand.

Oil shale is the only exploitable fossil energy resource of Jordan. Central Jordan's groundwater resources to the east of the Dead Sea were investigated in order to supply an oil shale plant with 22 million cu m/year of groundwater. The regional water balance for the two main aquifers based on hydrogeological investigations and on a numerical model indicates that the potential of the upper aquifer was previously overestimated. The present groundwater abstraction already exceeds the recoverable recharge, therefore only the minimum water demand of the plant of 5 million cu m/year can be withdrawn from this aquifer. An abstraction of the required quantity from the lower aquifer is feasible on a safe yield basis but technical aspects, i.e., deep drilling, excessively large pumping lists as well as economic and ecological aspects have to be considered. (See also W91-02672) (Author's abstract) W91-02720

WETLANDS AND GROUNDWATER: NEW CONSTRAINTS IN GROUNDWATER MANAGEMENT.

Universidad Complutense de Madrid (Spain). Dept. of Geodynamics.
For primary bibliographic entry see Field 6G.
W91-02722

MAYA UTILIZATION OF KARST GROUND-WATER RESOURCES.

Pennsylvania State Univ., University Park.
For primary bibliographic entry see Field 6D.
W91-02813

HYDROGEOLOGICAL APPROACH TO IN-VESTIGATION IN KARST FOR POSSIBLE MODIFICATION OF GROUNDWATER REGIME AND INCREASE OF RECOVERABLE DESERVES

GEOZAVOD, Belgrade (Yugoslavia). M. Komatina

Environmental Geology and Water Sciences EGWSEI, Vol. 16, No. 2, p 149-153, 1990. 7 fig, 5

Descriptors: \*Aquifer management, \*Aquifers, \*Groundwater management, \*Karst hydrology, \*Water resources development, \*Water resources management, Coastal areas, Flow control, Flow discharge, Geologic control, Groundwater movement, Groundwater reservoirs, Saline water intrusion, Saline-freshwater interfaces, Springs, Water yield.

An artificial contribution to groundwater reserves for water supply is a principal interest in modern hydrogeology. The fear of the inherent risk and uncertainty were invariably present wherever a resource was discovered in karst of a geosynclinal area; consequently progress has been limited. The reasons, however, for such a cautious approach are diminishing, because much knowledge has been obtained about these aquiferous rocks, especially through investigations in the regions of surface storage reservoirs. Better knowledge of karst features and the results achieved with surface reservoirs have indicated that large amounts of groundwater can be recovered. The conventional water investigation and recovery methods have made available only small safe yields equal to the lowest natural discharge (on the order of 100 L/sec). A reasonable use of a karst water resource and its better management cannot be considered without artificial control of the groundwater regime, i.e., without adjusting the regime to human demands. Artificial interventions in karst have generally been associated with overflow springs, which can be impounded easily and at a low cost to improve the water discharge regime. Some of the technical works in naked karst are: underground reservoirs, flow control through preferential paths, water recovery by lowering discharge level, and repumping springs. Isolation of fresh groundwater from hydrochemical sea encroachment in coastal karst districts is a difficult problem. However, water levels can be raised by damming a number of preferential waterways in certain localities, similar to those in the inland karst regions, for storage of some freshwater. This will result in a substantial decrease in saline water encroachment or in its elimination where large back water volume is involved. (Fish-PTT) An artificial contribution to groundwater reserves W91-02820

AQUIFER THERMAL ENERGY STORAGE: A NUMERICAL SIMULATION OF FIELD EXPERIMENTS IN CHINA.

Nanjing Univ. (China). Dept. of Earth Sciences. Y. Xue, C. Xie, and Q. Li.

Water Resources Research WRERAQ, Vol. 26, No. 10, p 2365-2375, October 1990. 15 fig, 3 tab, 24

Descriptors: \*Aquifers, \*China, \*Heat storage, \*Injection-production wells, \*Mathematical models, \*Model studies, \*Thermal energy, Heat transfer, Observation wells, Seasonal distribution, Water temperature.

#### Field 4-WATER QUANTITY MANAGEMENT AND CONTROL

#### Group 4B-Groundwater Management

Computer simulations for three seasonal aquifer Computer simulations for three seasonal aquifer thermal energy storage experiments were carried out in China. The flat-lying test site and its vicinity are covered with the Quaternary system. The test facility contains four injection-production wells, 34 observation wells and four special measuring wells at the test site. The governing equation of the mathematical model used to simulate the experiments contains convection, conduction and heat dispersion terms. For the mathematical model the ments contains convection, conduction and heat dispersion terms. For the mathematical model, the aquifer is assumed to be horizontal and of uniform thickness, with the cap rock and the rock bed above and below the aquifer are assumed impermeable to flow; aquifer properties are assumed to be isotropic and uniform in the vertical direction; flow is assumed to be steady; thermal equilibrium is considered to take place instantaneously between the water and the rock in the aquifer; and the effect of natural vertical convection due to the temperature difference between the cold and warm effect of natural vertical convection due to the temperature difference between the cold and warm water is ignored. The simulated temperatures agree very well with the observed field data. Total mean values of the absolute errors are 0.5 C for the single-well experiment, 0.7 C for the double experiment and 0.4 C for the multiwell experiment; relative error ranges from 2.8% to 4.5%. The simulated production temperatures and energy recovery ratios also agree very well with the field data. The results strongly indicate the validity of the model and simulation parameters used. Heat transfer through the fluid phase by heat dispersion in the governing equation is considered. (Author's abstract) stract) W91-02866

#### 4C. Effects On Water Of Man's Non-Water Activities

INFLUENCE OF SEDIMENT DISTURBANCE AND WATER FLOW ON THE GROWTH OF THE SOFT-SHELL CLAM, MYA ARENARIA L. Dalhousie Univ., Halifax (Nova Scotia). Dept. of Oceanography.
For primary bibliographic entry see Field 2L.
W91-02062

CHARACTERISTICS OF COARSE WOOD DEBRIS FOR SEVERAL COASTAL STREAMS OF SOUTHEAST ALASKA, USA. Oregon State Univ., Corvallis. Forest Research

Lab.
E. G. Robison, and R. L. Beschta.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 9, p 1684-1693, September 1990. 7 fig. 3 tab, 28 ref.

Descriptors: \*Alaska, \*Detritus, \*Land management, \*Streams, Aquatic habitats, Fish, Fish behavior, Habitats, Resource management, Stream

Coarse woody debris (>0.2 mm in diameter and 1.5 m long) was measured along five undisturbed low-gradient stream reaches; volume, decay class, and horizontal orientation in relation to channel flow of first-order, second-order, third-order, and fourth-order coastal streams were determined. Debris were also classified into four influence zones based on stream hydraulics and fish habitats. Average debris length, diameter and volume per piece increased with stream size. Eighty percent of debris volume of the first-order and the smaller second-order streams was suspended above or lying outside the bankfull channel, while less than 40% was similarly positioned in the fourth-order stream. Approximately one-third of all debris was oriented perpendicular to stream flow, regardless of stream size. First-order, second-order, and thirdorder streams had a higher proportion of recent debris in the channel than the fourth-order stream, most new debris being attributable to a major 1984 windstorm. Tree blowdown had a major influence windstorm. Tree olowdown and a major influence on debris distribution along the smaller storm reaches. Debris jams and accumulations in the largest stream were formed from floated debris. These characterizations are useful for evaluating the distribution and amount of woody debris associated with land-management activities. (Author's abstract) W91-02063

ESTIMATING EROSION RISK ON FOREST LANDS USING IMPROVED METHODS OF DISCRIMINANT ANALYSIS. Pacific Southwest Forest and Range Experiment

Facility Soldinwest Forest and Range Expersions, Arcata, CA.
For primary bibliographic entry see Field 2J.
W91-02181

USE OF THE INDEX OF BIOTIC INTEGRITY TO ASSESS THE IMPACT OF LAND MANAGEMENT ACTIVITIES ON LOW ORDER STREAMS IN NORTHERN IDAHO. Idaho Univ., Moscow. Dept. of Fish and Wildlife. For primary bibliographic entry see Field 5G. W91-02242

IMPACT OF SOIL SURFACE DETERIORA-TION ON RUNOFF PRODUCTION IN THE ARID AND SEMI-ARID ZONES OF WEST

AFRICA.
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Lome (Togo).
Centre ORSTOM du Togo.
C. Valentin, and A. Casenave.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 126-134, 5 fig, 8 ref.

Descriptors: \*Africa, \*Arid lands, \*Rainfall-runoff relationships, \*Semiarid lands, \*Soil types, Burkina Faso, Infiltration, Mapping, Niger, Prediction.

The most ready way of diagnosing environmental damage in the arid and semi-arid zones of West Africa is to survey the field itself. However, a systematic method is needed to alleviate problems systematic firemout is necessary to an evidence protecting of definition and interpretation. A descriptive and genetic typology of surface crusts is proposed for characterizing typical unit surfaces. Also, an infiltration is established for each type of unit surface based on simulated rainfall experiments. Since each unit surface represents a part of a mapping unit, the total amount of runoff can be evaluated on the scale of a watershed. Good correlation between the measured and calculated runoff has been ob-tained on seven watersheds in Burkina Faso and Niger. This system provides a simple method to assess the degree of environmental (soil) degradation and to forecast the subsequent changes in hydrologic regimes. (See also W91-02288) (Author's abstract) W91-02296

WAYS OF EVALUATING HUMAN-INDUCED IMPACTS ON THE FUNCTIONING OF WATERBODY ECOSYSTEMS.

Institute of Ecology of the Volga River Basin,

Institute of Ecology of the Volga River Basin, Tolyatti (USSR).
S. M. Konovalov, V. N. Pautova, L. A. Vihristyuk, and V. S. Sarvior. Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 921-932, 1990. 11 fig, 3 tab, 8 ref.

Descriptors: \*Aquatic environment, \*Ecosystems, \*Environmental impact, \*Reservoirs, \*Water pollution effects, \*Water quality, Economic aspects, Evaluation, Human impact, Population dynamics, Social aspects, Trophic level, Water pollution

An examination of data obtained at the Kuibyshev An examination of data obtained at the Kubysnev Reservoir, intended for use in determining the self-purification potential of aquatic ecosystems, has provided an approach for estimating the human-induced pollution-ecosystem response relationships. At the same time, recent methodological investigations have established more precisely the methodology for studying the interaction of pollut-ants with aquatic ecosystems: (1) more detailed ants with aquatic ecosystems: (1) more detailed investigations of the structure of each particular trophic level with complete identification of all the organisms comprising this structure; (2) studying the ecosystem structure on a seasonal, annual and long-term basis with due regard to the population

dynamics and ascertaining optimum conditions of dynamics and ascertaining optimum conditions of functioning of mass and scarce species at all trophic levels; (3) establishing trophic relationships and flows of energy, matter and information within each particular trophic level and between them; estimation of the energy flow in the ecosystem and its alterations in the presence of the human-induced loading, based on the concept of spatial heterogeneity of the ecosystem, a unit of measure being a field of concentration of the pertinent species at different trophic levels as well as that of chemical components: (4) carrying out a complete inventory components; (4) carrying out a complete inventory and an eco-technogene classification of the pollutant sources and establishing quantitative and qualitative characteristics of the flow and the pollution tative characteristics of the flow and the pollution spectrum; (5) studying specific deformations of the ecosystem in the zone of modal sources of pollution relative to the background status; (6) estimating the total loading on the waterbody, working out the respective environmental protection measures and predicting the impacts of the socio-economic development on the water quality. (Author's abstract) W91-02397

PRESENT SITUATION OF THE EUROPEAN FLOODPLAIN FORESTS.

Institute for Floodplains Ecology, Rastatt (Germa-

ny, F.R.). E. I. Was L. Wenger, A. Zinke, and K. A. Gutzweiler. Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 5-12, June 1990.

Descriptors: \*Data acquisition, \*Ecology, \*Envi-ronment, \*Flood plain forests, \*Flood plains, \*Forest ecosystems, \*Forests, \*Germany, \*Limnology, Austria, Forest watersheds, Hung formation systems, Reservoirs, Switzerland

Although the floodplain forests of Central Europe Aithough the floodplain forests of Central Europe form an immensely important ecosystem, information concerning their function is scant and they are disappearing at an alarming rate. Consequently, the Institute for Floodplains Ecology in Rastatt, Germany was commissioned to construct an extensive database of the European floodplains. To date, the study has demonstrated that, with the exceptions of Switzerland and Germany, no country in Europe has obtained complete information about its most important floodplain areas its forests and Europe has obtained complete information about its most important floodplain areas, its forests and their types. Although some of the countries were able to provide some incomplete but practical information (Austria, Germany, Hungary), most of them, even those where relatively large undeveloped alluvial rivers exist (i.e. France, Poland, Yugoslavia), could only supply fragmentary knowledge about their floodplain forests. Recent knowledge about their floodplain forests. Recent evidence has also indicated that river impoundment, channelization, and drainage have caused a rapid loss of these forests, particularly affecting the willow and poplar communities. It is concluded that a more complete understanding of floodplain function will aid in their future protection and management. (D'Agostino-PTT) W91-02471

GEOGRAPHICAL ASPECTS OF FORESTED WETLANDS IN THE LOWER UCAYALI, PERUVIAN AMAZONIA.

Instituto de Investigaciones de la Amazonia Peruana, Iquitos. For primary bibliographic entry see Field 2H. W91-02481

STATUS AND TRENDS OF U.S. WETLANDS AND DEEPWATER HABITATS.
National Wetlands Inventory, Washington, DC. B. O. Wilen, and W. E. Frayer.
Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 181-192, June 1990. 5 ref.

Descriptors: \*Ecological effects, \*Forest water-sheds, \*Land use, \*Wetlands, Agriculture, Data acquisition, Estuaries, Forest management, Re-sources management, Surveys, Urbanization.

Effective national management of U.S. wetlands requires current statistics on status and trends, as well as detailed wetland maps for impact assess-

#### WATER QUANTITY MANAGEMENT AND CONTROL—Field 4

#### Effects On Water Of Man's Non-Water Activities—Group 4C

ment and site-specific decisions. The present study demonstrates that significant changes in the amounts of wetlands and deepwater habitats have occurred in the United States since the nation's first settlement. In the mid-1970's only 99 of the original 215 million acres of wetlands remained in the conterminous 48 states. These encompassed 93.7 million acres of palustrine wetlands of which 49.7 million were forested, and 5.2 million acres of estuarine wetlands of which 0.5 million were either shrubs, scrub trees or forested. Currently, wetlands shrubs, scrub trees or forested. Currently, wetlands cover a land surface area approximately the size of California, with half of this acreage existing as forests. Alarmingly, the annual losses have averaged 458,000 acres, an area about half the size of Rhode Island, of which 66% are forested. The most significant cause of this habitat destruction is the development of agriculture, which alone is responsible for 87% of all wetland degadation and 90% of the forested-wetland losses. In contrast, urban development executive for only about 86% area of the forested-wetland losses. In contrast, urban development executive for only about 86%. 90% of the forested-wetland losses. In contrast, urban development accounts for only about 8% and 6% of the respective losses. It is concluded that there exists a pressing need for more intensive research and management of existing wetlands in order to maintain their current levels of fish and wildlife resources. (D'Agostino-PTT) W91-02483

ESTIMATING THE FORESTED-WETLAND RESOURCE IN THE SOUTHEASTERN UNITED STATES WITH FOREST SURVY

astern Forest Experiment Station, Asheville, NC.

J. B. Tansey, and N. D. Cost. Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 193-213, June 1990. 6 fig, 5 tab, 17

Descriptors: \*Ecological effects, \*Forest ecosystems, \*Land use, \*Wetland forests, \*Wetlands, Agriculture, Data interpretation, Florida, Georgia, North Carolina, Resources management, South Carolina, Urbanization, Virginia.

Industrial expansion, residential development and agricultural activities have caused major changes in forested-wetlands, significantly increasing their rates of depletion. Data from the most recent forest surveys in the states of Virginia, North Carolina, South Carolina, Georgia, and Florida were used to examine the wetland forest resources. Consistent estimation of the forested wetland resource is difficult due to dispute services mixes and babitat two estimation of the forested wettand resource is diffi-cult due to diverse species mixes and habitat types, weather cycles that influence hydroperiod, and the arbitrary timing of field visits. Using stand infor-mation collected on Forest Inventory and Analysis (FIA) permanent plots, the area of wetland timber-land in the southeastern United States was estimat-ed and described. This method was comparable to ed and described. This method was comparable to the classification method currently accepted by the EPA and the U.S. Army Corps of Engineers, which routinely considers indicator species, soil data, and hydroperiod. Criteria also used in the FIA algorithm included overstory and understory species occurrence, physiography, hydroperiod, and cover type data. It was concluded that this is a consistent and repeatable method which is potentially useful for future wetland delineation and management. (Author's abstract)

APPROACH TO THE INVENTORY OF FORESTED WETLANDS FOR TIMBER-HARVEST-ING IMPACT ASSESSMENT.
North Carolina State Univ. at Raleigh. School of

Forest Resources.
W. M. Aust, S. F. Mader, L. J. Mitchell, and R.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 215-225, June 1990. 1 fig, 3 tab, 36

Descriptors: \*Ecological effects, \*Forest ecosystems, \*Forest management, \*Land use, \*Management planning, \*Wetland forests, \*Wetlands, Alabama, Best management practices, Data interpretation, Economic aspects, Ecosystems, Forestry, Geohydrology, Nutrients, Primary productivity, Resources management, Sedimentation, Soil proportion

At present, available information describing the impact of forestry activities on forested-wetland functions is insufficient for use in planning optimal management strategies. A methodology has been developed to assess the impact of timber-harvesting in a tidal freshwater palustrine wetland in southwestern Alabama. Biophysical as well as socio-economic parameters were examined to estimate both stand timber stocks and the extent of disruption of ecosystem functions. Specifically, indices were chosen to detect changes in net primary dices were chosen to detect changes in net primary productivity, plant nutrient assimilative capacity, soil nutrient retention and transformation, decomposition, sedimentation rate, hydrology, and wild-fife habitat provision. Furthermore, methods were chosen for data collection efficiency, interpretive simplicity, and the ability to provide a relative index of both the integrity and recovery rates of a disturbed ecosystem. This assessment enables wetland managers to determine which parameters are sensitive to functional changes, as well as the relative effects of various harvesting methods for use in promoting best forest management practices. (Author's abstract) W91-02485

STATE WETLAND PROTECTION LEGISLA-TION AFFECTING FORESTRY IN THE NORTHEASTERN UNITED STATES. Southern Forest Experiment Station, New Orle-

For primary bibliographic entry see Field 6E. W91-02487

FEDERAL LEGISLATION AND WETLANDS PROTECTION IN GEORGIA: LEGAL FOUN-DATIONS, CLASSIFICATION SCHEMES, AND INDUSTRY IMPLICATIONS.

Georgia Univ., Athens. School of Forest Re-

For primary bibliographic entry see Field 6E.

FLOODING AND SALTWATER INTRUSION: POTENTIAL EFFECTS ON SURVIVAL AND PRODUCTIVITY OF WETLAND FORESTS ALONG THE U.S. GULF COAST.

Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.

S. R. Pezesnki, R. D. Delaune, and W. H. Patrick. Forest Ecology and Management FECMDW, Vol. 3/3, No. 1/4, p 287-301, June 1990. 4 fig. 3 tab, 64 ref. Supported by the Louisiana Educational Qual-ity Support Fund, Contract No. LEQSF (1987-90)-RD-A-7.

Descriptors: \*Floods, \*Global warming, \*Saline water intrusion, \*Soil-water-plant relationships, \*Swamps, \*Wetland forests, \*Wetlands, Coastal areas, Coastal zone management, Ecological effects, Flooding, Hardwood, Photosynthesis, Salinity, Stress, Sublethal effects, Trees.

The predicted global warming trend and resultant sea level rise will increase inundation and salinity along coastal regions worldwide. In addition, as water levels increase, saltwater will encroach farwater levels increase, saltwater will encroach farther inland in many areas. However, the resultant effects of these ecological changes on the major tree species of coastal forests are unknown. The present study, which evaluates tree-survival response to increased flooding and saltwater intrusion, demonstrates a substantial reduction of net photosynthesis in many bottomland hardwood and swamp-forest tree species on the U.S. Gulf Coast. The combination of flooding and salinity causes foliage damage and substantial reductions in carbon assimilation. The morphological response and reductions in gas exchange rates are closely associated with increases in salt levels. Exposure to concentrations greater than 3 parts per thousand concentrations greater than 3 parts per thousand causes both leaf burning and decline (up to 84%) in carbon assimilation rates in seedlings, of some species. In addition, the sublethal stress can lead to weaker seedlings, and consequently, reduced survival rates of the susceptible species. (D'Agostino-W91-02489

CAT ISLAND SWAMP: WINDOW TO A FADING LOUISIANA ECOLOGY. Southern Forest Experiment Station, New Orleans, LA.

M. S. Devail.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 303-314, June 1990. 2 fig. 5 tab, 22

Descriptors: \*Cat Island Swamp, \*Forest ecosystems, \*Land management, \*Louisiana, \*Swamps, \*Wetland forests, Data acquisition, Ecological effects, Ecosystems, Species composition, Species diversity, Wetlands.

Currently, there is considerable awareness of the ecological importance of forested-wetlands, as well as an increasing concern over the long-term consequences of continued wetland losses. Future preservation of these habitats is predicated on understanding the secological control of the second o ervation of these habitats is predicated on under-standing the topology of present swamp-forest communities, such as Cat Island swamp which borders the Mississippi River in Louisiana. In this tract, twenty species of trees were observed in six communities. Hadkberry (Celtis laevigata) had the highest importance value, followed by cypress (Taxodium distichum), green ash (Fraxinus penn-sylvanica), and Tupelo gum (Nyssa aquatica). The understory was sparse, and saplings were not rep-resented in the same frequency as mature trees. Of particular note is that no saplings of cypress, or of five other species, were present, suggesting an important future change in forest composition. Dis-criminant-function analysis indicated that of all the environmental variables considered, including soil conditions and nutrient status, changes due to conditions and nutrient status, changes due to human activities, such as lumbering, had the most significant influence on swamp tree survival and distribution. (D'Agostino-PTT)
W91-02490

POSSIBLE EFFECTS OF RESIDENTIAL DE-VELOPMENT ON STREAMFLOW, RIPARIAN PLANT COMMUNITIES, AND FISHERIES ON SMALL MOUNTAIN STREAMS IN CENTRAL

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab.

A. I. Medina

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 351-361, June 1990. 2 fig, 2 tab, 22

Descriptors: "Arizona, "Ecological effects, "Fisheries, "Forests, "Pine trees, "Regional development, "Streamflow, "Urbanization, Comparison studies, Ephemeral streams, Riparian vegetation.

Increased residential development along small mountain streams within the pine forests of central Arizona has surged within the last 20 years, presenting a potential threat to riparian plant communities due to the alteration of streamflow from perennial to ephemeral. This alteration significantly increases the water stress on plant populations. Measurements of tree densities and stand composition of Arizona alder (Alnus oblongifolia) and box elder (Acer negundo) showed that perennial stream reaches had greater tree densities in all diameter classes, compared with enhemeral stream diameter classes, compared with ephemeral stream reaches where small-diameter trees were absent. reaches where small-diameter trees were absent.

Xylem water potential measurements decreased
more rapidly on trees occupying ephemeral stream
reaches than on trees of comparable reaches of
perennial streams over time during the summer.
The increase in water stress in trees growing along
ephemeral stream reaches may be responsible for ephemeral stream reaches may be responsib epnemeral stream reacnes may be responsible for both the lower plant densities and lack of seedling establishment observed. Trout populations also de-cline when perennial streamflow changed to ephemeral. (Author's abstract) W91-02493

UTILITY OF STREAM HABITAT AND BIOTA FOR IDENTIFYING POTENTIAL CONFLICT-ING FOREST LAND USES: MONTANE RIPAR-IAN AREAS.

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab. J. N. Rinne.

#### Field 4-WATER QUANTITY MANAGEMENT AND CONTROL

#### Group 4C-Effects On Water Of Man's Non-Water Activities

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 363-383, June 1990. 6 fig, 91 ref.

Descriptors: \*Forest ecosystems, \*Forest watersheds, \*Forests, \*Land use, \*Riparian vegetation, \*Streams, \*Wetlands, Data acquisition, Fish, Literature review, Macroinvertebrates, Particle size, Sediment distribution.

Since National Forest lands in the United States are managed through a multiple-resource approach, adopted practices often impose a conflict between two or more forest land uses. In addition, aithough many studies have assessed the impact of such land use practices on riparian stream areas, the practical usefulness of these approaches has not been clearly demonstrated. Through a review of the literature this study suggests the feasibility of using one physical feature of stream habitat, namely fine sediment, and two biological variables, aquatic macroinvertebrates and fish, to identify the effects of multiple use activities on riparian stream systems. Based on empirical data obtained from several southwestern montane streams, plus infor-Since National Forest lands in the United States several southwestern montane streams, plus inforseveral soutnwestern montaine streams, plus intor-mation derived from the existing literature, it was concluded that these three variables are valid indi-cators for detection of the effects of multiple use activities on riparian stream ecosystems. It was further concluded that multiple physical and biotic factors, such as solar radiation, water quality, water temperature, and type of vegetation, must also be considered for optimal management of the valuable forested wetlands. (D'Agostino-PTT) W91-02494

LONG-TERM TRENDS IN THE BALD-CY-PRESS (TAXODIUM DISTICHUM) RESOURCE IN LOUISIANA (U.S.A).

Louisiana State Univ., Baton Rouge. Center for Wetland Resources.

For primary bibliographic entry see Field 2H. W91-02501

EDUCATED GUESSES: HEALTH RISK AS-SESSMENT IN ENVIRONMENTAL IMPACT STATEMENTS.

P. D. Harvey.

American Journal of Law & Medicine AJLMDN,
Vol. 16, No. 3, p 399-427, 1990. 185 ref.

Descriptors: \*Environmental impact, \*Environ-mental impact statement, \*Environmental policy, \*Environmental quality, \*Public health, \*Risk as-sessment, Administrative agencies, Environmental effects, Federal jurisdiction, Project planning, Reg-

Efforts to protect the environment and public health from environmental pollution begin with describing potential adverse consequences of human activities and characterizing the predicted risk. The National Environmental Policy Act (NEPA) requires the preparation of environmental impact statements (EIS) to describe the effects of proposed federal projects and provide information for agency decision makers and the public. The scope of the EIS requirement has been delineated by regulations and frequent lawsuits and covers all by regulations and frequent lawsuits and covers all federal agencies planning any major project, including construction, ongoing management pro-grams, provision of funds, and approval of permits eeded by state and local governments or private usinesses. In 1978, the Council on Environmental businesses. In 1978, the Council on Environmental Quality (CEQ) promulgated regulations binding on all federal agencies to provide uniform standards for the implementation of NEPA. A worst case analysis requirement continues in importance as an historical perspective on approaches to the problem of inadequate information. In 1986, CEQ rejected the worst case analysis requirement and replaced it with more clearly articulated and manageable requirements. Agencies must still evaluate catastrophic/low probability consequences, and there was little change in the framework for EIS expression of uncertainties. The methodologies for risk assessment are complex and vulnerable to bias from underlying assumptions and policy judgerisk assessment are complex and vunerable to bias from underlying assumptions and policy judge-ments. Components of a risk assessment methodol-ogy may include dose-response assessment, popula-tion exposure assessment, and risk characterization. Recommendations for use of risk assessment in EIS

include clear statement of assumptions and scientific judgements, delineation of the nature and magnitude of uncertainties, separation of risk assessment and risk management, explanation of the choice of methodology, presentation of risk estimates, and specification of the role of risk assessment in decision making. (MacKeen-PTT) W91-02508

NEW APPROACH FOR OPTIMIZATION OF URBAN DRAINAGE SYSTEMS.

Bradford Univ. (England). Dept. of Civil Enginer-ing and Structural Engineering. For primary bibliographic entry see Field 5D. W91-02575

ROLE OF GROUNDWATER QUALITY IN THE DECISION-MAKING PROCESS FOR WATER RESOURCES

Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos. For primary bibliographic entry see Field 5G. W91-02680

MANAGEMENT OF GROUNDWATER-IN-DUCED RIVER SALINITY DUE TO LAND CLEARING IN THE MURRAY BASIN, SOUTH-EASTERN AUSTRALIA. South Australian Dept. of Mines and Energy, Ade-

laide. For primary bibliographic entry see Field 5G. W91-02681

ARTIFICIAL RECHARGE PILOT PROJECTS IN GUJARAT, INDIA. Birmingham Univ. (England). Dept. of Civil Engineering. For primary bibliographic entry see Field 4B. W91-02717

GRAVEL EXTRACTION AND WATER RESOURCES MANAGEMENT OF THE DENGE GRAVEL AQUIFER, KENT, ENGLAND. Aspinwall and Co., Shrewsbury (England). P. A. Marsland, and D. H. Hall. IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 29, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 605-621, 6 fig, 1 tab, 4 ref.

Descriptors: \*Aquifer management, \*England, \*Environmental impact, \*Gravel mining, \*Environmental impact, \*Gravel mining, \*Groundwater management, \*Groundwater re-sources, \*Water resources management, Case studies, Databases, Finite difference methods, Geohy-drology, Groundwater level, Groundwater movement, Groundwater quality, Groundwater re-charge, Habitat restoration, Model studies, Monitoring, Surface-groundwater relations, Water qual-

Denge Beach, on the southeastern coastline of England, is an 'environmentally sensitive' area that is under increasing pressure from a combination of is under increasing pressure from a combination of man-made and natural forces, including gravel extraction, water abstraction and storm surges. Recent hydrogeological studies were conducted to assess the impact of gravel extraction on the resources of the Denge gravel aquifer. A finite difference model, that incorporates the findings of extensive investigations over the past 10-15 years, has been constructed; complex boundary conditions and anisotropy are integrated into the model. A scheme has been developed to reduce groundwater discharge to surface water courses by restoring gravel workings at the edge of the aquifer with less permeable silt. Modeling indicates that this scheme will maintain and increase water levels in the aquifer, compared with those predicted for the original restoration proposals. The model may also be used restoration proposals. The model may also be used as a baseline against which actual monitoring data can be checked and as an assessment of the progress of the scheme made as development proceeds. The large volume of monitoring data has made it possible to develop a model that can be tested against a large range of environmental and

man-made factors. The interaction of wet mineral workings on aquifer storage, recharge, and water quality can only be assessed with confidence by he use of modeling techniques. The ever-incre the use of modeling techniques. The ever-increasing pressure on mineral extractors to reduce the environmental impact of their workings, coupled with developmental pressures that look for progressively deeper and often sub-watertable workings, is likely to increase the need for this type of study. (See also W91-02672) (Fish-PTT) W91-02723

ECOSYSTEM MODELLING: SCIENCE OR TECHNOLOGY.

Goettingen Univ. (Germany, F.R.). Abt. Bodenkunde und Waldernahrung.
For primary bibliographic entry see Field 2H. W91-02736

EFFECTS OF VEGETATION TYPE ON THE BIOGEOCHEMISTRY OF SMALL CATCH-MENTS (MONT LOZERE, FRANCE).
Orleans Univ. (France). Lab. d'Hydrogeologie.

For primary bibliographic entry see Field 2K. W91-02742

PRECIPITATION, THROUGHFALL, SOIL SO-LUTION AND STREAMWATER CHEMISTRY IN A HOLM-OAK (QUERCUS ILEX) FOREST. Universidad Autonoma de Barcelona (Spain). Centre de Recerca Ecologica i Aplicacions Fores-

For primary bibliographic entry see Field 2K. W91-02744

HYDROGEOCHEMICAL VARIATIONS IN HAFREN FOREST STREAM WATERS, MID-

Institute of Hydrology, Wallingford (England). C. Neal, C. J. Smith, J. Walls, P. Billingham, and

Journal of Hydrology JHYDA7, Vol. 116, No. 1/ 4, p 185-200, August 1990. 10 fig, 2 tab, 25 ref.

Descriptors: \*Acid rain effects, \*Forest hydrology, \*Forest management, \*Forest watersheds, \*Geochemistry, \*Streams, \*Wales, \*Water chemistry, Bromides, Clear-cutting, Conifers, Groundwater, Hydrogen ion concentration, Iodine, Model studies, Nitrates, Nutrients, Organic carbon, Runoff, Spruce trees, Storm water.

Results are presented for a study to assess the effects of conifer planting/harvesting and acidic oxide deposition on streamwater quality in a 25 to 45-year-old sitka spruce planation on acid moorhald. Hafren forest streamwater chemistry varies for different components: nitrates, bromide, total iodine and total organic carbon show seasonal oscillations varying in phase and amplitude; aluminum and hydrogen ion concentrations vary as a function of flow; manganese and cobalt remain approximately constant except under dry conditions when concentrations reduce by up to 10 fold. Streamwater chemistry variations are determined primarily by hydrological and chemical reactions in the surface organic-rich soils and the underlying inorganic soils/bedrock. Biologically mediated breakdown processes determine, in part, the hydrochemical behavior of dissolved organic carbon, the nutrients, bromine and iodine. Reactions in the drochemical behavior of dissolved organic carbon, the nutrients, bromine and iodine. Reactions in the inorganic zones involve hydrogen ion consumption and the release of calcium and magnesium. Bicarbonate ions are generated by deprotonation of biogenically derived H2CO3 and the decomposition of calcium carbonate in the bedrock. The initial effects of forest clearfelling are demonstrated; increases in nitrate and potassium occur. A simple mixing model is presented to show that either a creases in intrate and potassium occur. A simple mixing model is presented to show that either a large proportion of the storm water is derived from non-hilslope, groundwater sources, sources, or major modifications occur as soil water passes rapidly to the stream; whichever process is operative, it has not been identified directly within the catchment monitoring program. (Author's ab-W91-02745

### Watershed Protection—Group 4D

HYDROLOGICAL AND HYDROCHEMICAL FLUXES THROUGH VEGETATION AND SOIL IN THE ALLT A'MHARCAIDH, WESTERN CAIRNGORMS, SCOTLAND: THEIR EFFECT ON STREAMWATER QUALITY. Macaulay Land Use Research Inst., Aberdeen (Scotland).

For primary bibliographic entry see Field 5B. W91-02749

SHORT-TERM IONIC RESPONSES AS INDI-CATORS OF HYDROCHEMICAL PROCESSES IN THE ALLT A'MHARCAIDH CATCHMENT. WESTERN CAIRNGORMS, SCOTLAND.
Freshwater Fisheries Lab., Pitlochry (Scotland).
For primary bibliographic entry see Field 5B.
W91-02750

EFFECT OF CLEARFELLING A SITKA SPRUCE (PICEA SITCHENSIS) PLANTATION ON SOLUTE CONCENTRATIONS IN DRAIN-

ON SOLUTE CONCENTRATIONS IN DRAIN-AGE WATER.
Institute of Terrestrial Ecology, Grange over Sands (England). Merlewood Research Station.
J. K. Adamson, and M. Hornung.
Journal of Hydrology JHYDA7, Vol. 116, No. 1/4, p 287-297, August 1990. 2 fig, 2 tab, 20 ref.

Descriptors: \*Acid rain effects, \*Clear-cutting, \*Forest management, \*Forest watersheds, \*Land use, Aluminum, Chlorides, Drainage systems, Drainage water, England, Experimental basins, Hydrogen ion concentration, Ion transport, Ions, Nitrates, Phosphates, Potassium, Runoff, Sodium, Solutes, Spruce trees, Sulfates, Sylviculture, Water chemistry, Water sampling.

Water samples were collected from the drainage system of a Sitka spruce plantation at weekly intervals for six years. The drainage system had been designed to divide the plantation into a series of artificial catchments, three of which were designated experimental plots and clearfelled in the second year of sampling while a fourth was the control plot which remained unfelled until the end of the study. Prior to felling, solute concentrations were similar for all plots. Concentrations of nitrate, potassium, and phosphate all rose following felling. Nitrate concentrations peaked one year after the end of felling and returned to levels similar to the control plot in the fourth year after felling. Potassium and phosphate peaked in the second year after felling but had not returned to control levels by the end of the study, although seasonal patterns had become established, with lower concentrations in summer. Concentrations of sulphate, sodium, and chloride declined as a result of felling and in summer. Concentrations of sulphate, sodium, and chloride declined as a result of felling and remained lower than the control at the end of the study. There was a very slight fall of pH and aluminum concentration after felling, relative to the control. The three experimental plots behaved in a similar way for all ions except phosphate and iron which were released in greatest quantities from the least intensively drained plot. (Author's bettern!) abstract) W91-02751

## FLOOD DYNAMICS OF A CONCRETE-LINED, URBAN STREAM IN KANSAS CITY, MISSOU-

Jacksonville State Univ., AL. Dept. of Geography

Jacksonvine Sandand Geology.
D. M. Vaughn.
Earth Surface Processes and Landforms ESPLDB,
Vol. 15, No. 6, p 525-537, September 1990. 6 fig, 3

Descriptors: \*Flood channels, \*Flood discharge, \*Hydrodynamics, \*Urban hydrology, \*Watershed management, Channel flow, Channel morphology, Channel scour, Flow velocity, Kansas, Missouri,

Brush Creek drains a 76.1 sq km watershed within urban Kansas City, Missouri and eastern Kansas. A concrete-lined reach trending 6.1 km through the Plaza District of Kansas City, Missouri, has been the focus for several major floods over the past ten years. Channel geometry, slope, and floodwater elevations were determined in the field for seg-

ments of the concrete-lined section of Brush Creek for a flood event that occurred on September 18, 1986. Discharge was computed by indirect meth-ods and compared to a value determined from a rating curve established by the Water Resources Division of the U.S. Geological Survey. Boundary Division of the U.S. Geological Survey. Boundary shear stress, unit stream power, and average velocity were also computed in order to establish a quantitative relationship between sediment distribution, volume, and size fractions; and flow dynamics operating throughout the channel during this event. Boundary shear stress ranged from 91-96 N/sq m, stream power was 528-557 W/sq m, while average velocity was 5.8 m/s. These values were sufficient to displace concrete slabs as large as 5 m long by 4.6 m wide by 0.23 m thick weighing an estimated 12,245 kg. As the channel was sediment-free and unscoured prior to the flood, the distribution of deposits and subsequent channel scour provide valuable evidence for potentially hazardous sections of this urban stream. (Author's abstract) 's abstract) W91-02809

# PREDICTING RUNOFF FROM RANGELAND CATCHMENTS: A COMPARISON OF TWO

MODELS.
Agricultural Research Service, Boise, ID. Northwest Watershed Research Center.
For primary bibliographic entry see Field 2E.
W91-02869

CORRELATION OF EROSION MEASURE-MENTS AND SOIL CAESIUM-137 CONTENT. Soil Conservation Service, Gunnedah (Australia). For primary bibliographic entry see Field 2J. W91-02913

# ANALYSIS OF HYDROLOGIC IMPACT OF QUARRYING SYSTEM BY 3-D FINITE ELE-MENT MODEL.

MENT MODEL.

Padua Univ. (Italy). Dipt. di Metodi e Modelli Matematici per le Scienze Applicate.

G. Gambolati, and G. Galeati.

Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 11, p 1388-1402, November 1990. 11 fig. 29 ref.

Descriptors: \*Finite element method, \*Ground-water movement, \*Hydrological regime, \*Model studies, \*Quarries, \*Water table fluctuations, Allu-vial plains, Borrow pits, Design criteria, Environ-mental impact, Excavation, Italy, Nuclear power-plants, Numerical analysis, Three-dimensional plants, model.

The excavation of an extensive quarrying system in alluvial plains to supply building material may induce water table modifications that are not compatible with the natural environment or with the existing activities (e.g., agricultural or recreational) in the area. The hydrologic impact of a set of borrow pits designed to provide the material needed for the construction of an electro-nuclear plant at Trino Vercellese, northwestern Italy, was analyzed with the aid of a 3-D finite element model analyzed with the aid of a 3-D finite element model of subsurface flow. The results from the simulations show that a single quarry induces water-table changes that are considered to be unacceptable from the environmental point of view. Close to the excavation boundary, the water level can rise more than 1 m, with possible flooding of nearby areas. Also, outside the electro-nuclear plant property an increase or decrease of 0.2 m is considered to be significant. The results also show that the groundwater regime is not altered either transversely or water regime is not altered either transversely or longitudinally if the excavation volume is frac-tioned into six distinct cavities and the downstream wall of each cavity is made impermeable through the deposition of a layer of fine sediments or the application of a thin plastic foil. (Fish-PTT) W91-02921

# IMPACT OF SYNTHETIC LEACHATE ON THE HYDRAULIC CONDUCTIVITY OF A SMECTITIC TILL UNDERLYING A LANDFILL NEAR SASKATOON, SASKATCHEWAN. National Hydrology Research Inst., Saskatoon (Saskatchewan). Ground Water Div.

For primary bibliographic entry see Field 5E. W91-02943

#### 4D. Watershed Protection

MEASURING SOIL LOSS IN DIFFERENT LAND-USE SYSTEMS ON AN OXIC PALEUS-TALF IN LUSITU, ZAMBIA. Zambia Univ., Lusaka

V. R. N. Chinene, D. Mbewe, and D. Lungu. Tropical Agriculture TAGLA2, Vol. 67, No. 3, p 221-222, July 1990. 1 fig, 1 tab, 5 ref.

Descriptors: \*Developing countries, \*Erosion control, \*Land use, \*Soil erosion, Agriculture, Cowpeas, Crop yield, Groundnut, Millet, Productivity, Runoff, Zambia.

Erosion hazards in the Lusitu, Zambia area are one of the constraints limiting sustainable land produc-tivity. Soil loss was measured using the runoff plot technique in five cropping systems (millet, bam-bara groundnuts, millet and bambara groundnuts, bara groundnuts, millet and bambara groundnuts, cowpeas, and millet and cowpeas) and a bare plot. Considerable variation in soil loss was apparent between different cropping systems. In the bare plot more than 12 tons soil per ha was lost. In millet and its intercrops, soil loss was nearly 50% lower than in the bare plot. Millet produced higher yields when intercropped with bambara groundnuts, and cowpea. Similarly, bambara groundnuts and cowpeas produced higher yields when intercropped with millet. Definite differences were demonstrated between cropping systems in consequences. cropped with millet. Definite differences were demonstrated between cropping systems in controlling soil loss. Crop cover by itself has the capacity to reduce soil loss by nearly 50%. Crops such as bambara groundnuts and cowpeas which develop small leaf canopies should only be grown as intercrops to minimize soil loss and optimize productivity. (Brunone-PTT) W91-02078

#### WATER DROPLET ENERGY AND SOIL AMENDMENTS: EFFECT ON INFILTRATION AND EROSION.

Soil and Irrigation Research Inst., Pretoria (South Africa)

For primary bibliographic entry see Field 2G. W91-02136

### SLOPE, ASPECT, AND PHOSPHOGYPSUM EFFECTS ON RUNOFF AND EROSION.

Soil Erosion Research Station, Natanya (Israel). For primary bibliographic entry see Field 2E. W91-02139

USE OF RUN OFF ON CULTIVATED FIELDS USE OF RUN UPF ON CULTIVATED FIELDS
IN THE SUDAN-SAHELIAN AREA: BURKINA
FASO, YATENGA PROVINCE, BIDI REGION
(VALORISATION AGRICOLE DES EAUX DE
RUISSELLEMENT EN ZONE SOUDANO SAHELIENNE: BURKINA FASO, PROVINCE DU
YATENGA, REGION DE BIDI).

Institut Français de Recherche Scientifique pour le Developpement en Cooperation, Ouagadougou (Burkina Faso). Centre ORSTOM a Ouagadougou. For primary bibliographic entry see Field 3F. W91-02365

# PREDICTION ON EUTROPHICATION OF RESERVOIR YUQIAO.

Tianjin Inst. of Environmental Protection and Sciences (China).

For primary bibliographic entry see Field 5G. W91-02383

# NOURISHMENT OF PERCHED SAND DUNES AND THE ISSUE OF EROSION CONTROL IN THE GREAT LAKES.

Michigan Univ.-Flint. Dept. of Resource Science. For primary bibliographic entry see Field 2J. W91-02821

#### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 5A-Identification Of Pollutants

#### 5. WATER QUALITY MANAGEMENT AND PROTECTION

#### 5A. Identification Of Pollutants

EVALUATION OF THE SEA URCHIN ECHIN-OMETRA IUCUNTER AS AN INDICATOR OF HEAVY-METAL CONTAMINATION IN CUBA CONTAMINATION IN CUBA
(EVALUACION DEL ERIZO DE MAR ECHINOMETRA IUCUNTER COMO INDICATOR DE
CONTAMINACION POR METALES PESADOS,

Havana (Cuba). Unidad de Proteccion Ambiental. N. Ablanedo, H. Gonzalez, M. Ramirez, and I.

Aquatic Living Resources ALREEA, Vol. 3, No. 2, p 113-120, 1990. 5 fig, 4 tab, 21 ref. (English mary).

Descriptors: \*Bioindicators, \*Cuba, \*Echino-derms, \*Heavy metals, \*Marine pollution, \*Path of pollutants, \*Statistical analysis, Analysis of vari-ance, Cluster analysis, Copper, Data interpretation, Havana, Iron, Manganese, Mercury, Pollutant identification, Tissue analysis, Water quality, Zinc.

Between March 1986 and June 1987, the content of Between March 1986 and June 1987, the content of iron, zinc and manganese in the hard parts, and the content of iron, copper, zinc and mercury in the gonads, of the sea urchin Echinometra Iucunter were studied. The specimens were collected from sites on the rocky shore of Havana, Cuba, which had different levels of heavy metal pollution. The sampling sites were Santa Cruz, Rincon de Guanabo, Alamar, Boca de la Bahia, Nautico and Santa Fe. Differences were found in the metal content of both the gonads and the hard parts. These differences were found in the metal content of the theory of the same parts. Fe. Differences were found in the metal content of both the gonads and the hard parts. These differences were explained by the triglyceride content of the gonads and the higher organic content of the gonads, (> 90%), compared with 13% for the hard parts. The results were processed by analysis of variance (ANOVA) and cluster analysis. Seasonal variations were found by ANOVA. The differences between the sites that had been studied indicate that the gonads can act as an indicator of ton and mercury collution and the hard parts as iron and mercury pollution and the hard parts as an indicator of iron, zinc and manganese pollution. (Author's abstract)

TOTAL HEAVY METAL CONCENTRATIONS CONTAINED ON THE SEDIMENT'S SURFACE OF ALGIERS BAY.

Laboratoire de Chemie Marine, Algiers (Algeria). For primary bibliographic entry see Field 5B.

TOXICITY TEST FOR WATER AND WASTE WATER: ALDEHYDE DEHYDROGENASE INHIBITION TEST IN CUVETS AND MICROTTER PLATES (TOXIZITAETSTESTS FUER WASSER UND ABWASSER: KUEVETTENUND MIKROTITERPLATTENTEST MIT ALDEHYDDEHYDROGENASE).

Wasserforschung Mainz G.m.b.H. (Germany F.R.).
M. Wiegand-Rosinus, K. Haberer, U. Obst, and A. Wild. Mainz G.m.b.H. (Germany,

Wild. Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 23, No. 3, p 98-101, June 1990. 4 fig, 4 tab, 3 ref. English summary.

Descriptors: \*Analytical techniques, \*Laboratory methods, \*Pesticides, \*Toxicity, \*Wastewater analysis, \*Water analysis, Aldehyde dehydrogenase, Captafol, Dithiocarbamates, Fentinacetate, Maneb,

Based on the inhibition of aldehyde dehydrogenase by pesticides, an enzymatic toxicity test is present-ed for testing water and wastewater. The test protocols are given for photometric measurement in cuvets and fluorometric measurement in micro-titer plates. Using microtiter plates minimizes the costs by saving expensive reagents, and enables the testing of a higher quality of samples by rapid measurement of dilution series. The results of 17 tested pesticides are described: the dose-response curves of Maneb, Captafol and Fentinacetate are shown as examples. Dithiocarbamates inhibit aldesnown as examples. Difinicaroamates minoit auc-hyde dehydrogenase in a low ppt range. The test in microtiter wells is more sensitive because of the lower concentration of substrate, enzyme and coenzyme in molecular rate. (Author's abstract) W91-02056

COASTAL WATER POLLUTION: DISSOLVED HEAVY METALS AND SUSPENDED PARTIC-ULATE MATTER,

Patras Univ. (Greece)

Patras Univ. (Greece).

A. Koliadima, and G. Karaiskakis.

Zeitschrift fuer Wasser - und Abwasser Forschung
ZWABAQ, Vol. 23, No. 3, p 102-105, June 1990. 2
fig, 6 tab, 10 ref. International Atomic Energy
Agency Contract 4621/EP.

Descriptors: \*Greece, \*Heavy metals, \*Path of pollutants, \*Pollutant identification, \*Water pollution sources, Cadmium, Copper, Lead, Marine pollution, Particle size, Patras, Photosedimentation, Polarographic analysis, Suspended sediments, Water quality, Zinc.

Concentrations of the heavy metals, Zn, Cd, Pb, and Cu dissolved in coastal water samples collected from around the city of Patras, were measured over a period of one year, with a frequency of one sample per month, by polarographic methods. Lower annual mean concentrations of dissolved Zn and Cu were found in coastal locations close to Zn and Cu were found in coastal locations close to the mouths of rivers, while the annual mean con-centrations of dissolved Cd and Pb were found to be independent of the sampling location. The mean number diameter of the suspended particulate matter, as measured by photosedimentation, was found to increase with a decrease in the concentra-tion of dissolved Zn, as well as an increase in the concentration of the dissolved Cu. (Author's abstract) W91-02057

SORPTION LAYERS IMPREGNATED WITH AMMONIUM MOLYBDATE FOR THE THIN LAYER CHROMATOGRAPHY IN ORDER TO EVALUATE PHENOL CONTAMINATED WATERS (AMMONIUMMOLYBDATIMPAEGI-NIERTE SORPTIONSCHICHTEN FUER DIE DUENNSCHICHTCHROMATOGRAPHIE ZUR BEURTEILUNG PHENOLKONTAMINIERTER WAESSER).

Kreiskrankenhaus Treuenbrietzin (German D.R.). H. Thielemann.

ZWABAQ, Vol. 23, No. 3, p 113-115, June 1990. 1 tab, 2 ref. English summary.

Descriptors: \*Analytical techniques, \*Chemical analysis, \*Phenols, \*Pollutant identification, \*Thin layer chromatography, \*Water analysis, Aromatic compounds, Benzenes, Dihydroxybenzene, Industrial wastewater, Laboratory methods, Trihydrox-

The application of thin layer chromatography to evaluate phenolic contamination in water is discussed. The mobile phase for separating bifunctional phenols is a mixture of: toluene; 49%; acctone, 35%; and chloroform, 25%. The mobile phase for the separation of polyfunctional phenolic compounds is composed of: benzene, 70%; and acctone, 30%. The stationary phase was composed of a wide-pore silica gel treated with a 5% solution of ammonium molybdate and air dried at 80-100 C. Phenolic compounds separated include 1,2-dihy-Phenolic compounds separated include 1,2-dihy-droxybenzene, 1,3-dihydroxybenzene, 1,4-dihydroxybenzene, 1,3-trihydroxybenzene, 1,3,5-trihydroxybenzene, and 1,2,4-trihydroxybenzene. (King-PTT) W91-02059

RESPONSE AND RECOVERY OF BRAIN ACE-TYLCHOLINESTERASE ACTIVITY IN AT-LANTIC SALMON (SALMO SALAR) EXPOSED TO FENITROTHION.

Department of Fisheries and Oceans, St. John's (Newfoundland). Science Branch.

M. J. Morgan, L. L. Fancey, and J. W. Kiceniuk. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 9, p 1652-1654, September 1990. 1 tab, 20 ref.

Descriptors: \*Acetylcholinesterase, \*Bioindicators, \*Fenitrothion, \*Fish physiology, \*Insecticides, \*Pesticides, \*Salmon, \*Water pollution effects, Enzyme activity, Marine pollution, Metabolism, Organophosphorus pesticides, Pesticide toxicity.

Exposure to organophosphorus insecticides is known to decrease the activity of brain acetylcholinesterase, and a 20% decrease in the enzyme's linesterase, and a 20% decrease in the enzyme's activity relative to controls is taken as evidence that animals have been in contact with an organophosphorus pesticide. Atlantic salmon (Salmo salar) parr were exposed to a number of concentrations of either technical grade fenitrothion or an operational formulation of the pesticide for 7 days or to the operational formulation for two, 24 hour periods separated by seven days. Paris activities periods separated by seven days. Brain acetylcho-linesterase (AChE) activity decreased as concenlinesterase (AChE) activity decreased as concentration of fenitrothion increased. Recovery period was directly related to amount of depression, with recovery of AChE from exposure to 0.004 microl/L fenitrothion taking less than one week. Samples must be taken soon after spray operation to detect exposure to such low levels of fenitrothion through AChE monitoring. The use of AChE activity measurements as a monitoring tool in aquatic systems should reliably detect exposure to dangerous levels of fenitrothion which might produce significant population changes. (Brunone-PTT) W91-02061

PRECONCENTRATION OF COPPER ON ALGAE AND DETERMINATION BY SLURRY GRAPHITE FURNACE ATOMIC ABSORPTION SPECTROMETRY.

Texas Univ. at Austin. Dept. of Chemistry and Biochemistry.

M. Shengjun, and J. A. Holcombe. Analytical Chemistry ANCHAM, Vol. 62, No. 18, p 1994-1997, September 15, 1990. 4 fig, 4 tab, 8 ref. Robert A. Welch Foundation Grant F1108.

Descriptors: \*Atomic absorption spectrophotometry, \*Chemical analysis, \*Chlorella, \*Copper, \*Laboratory methods, \*Pollutant identification, \*Preconcentration, \*Water analysis, \*Water treatment, Adsorption, Freshwater, Heavy metals, Hydrogen ion concentration, Seawater.

Unicellular green algae (Chlorella) were utilized to preconcentrate Cu ions from seawater and riverine water samples. Studies show that after the algae are rinsed with 1% HCl, Cu adsorption on the algae is improved. The addition of sodium citrate and dodecyl sulfate can also improve Cu adsorption. The algae weight and the solution pH are not critical. The seawater matrix does not affect the addentition of figures and the solution pH are not critical. The seawater matrix does not affect the addentition of figures in the content of the seawater matrix does not affect the addentition of figures in the content of the seawater matrix and the solution pH are not critical. critical. The seawater matrix does not affect the adsorption efficiency for Cu. Cu preconcentration can be achieved by mixing 6 mg of algae with 10-100 ml of sample and subsequently separating by centrifugation. The algae pellet is then resuspended in 1 ml of 0.5% HNO3 and analyzed as a slurry by graphite furnace atomic adsorption spectrometry. The determined values of Cu in riverine (SLRS-I) and seawater (CASS-1) standard reference materials are within the limits of certification. (Author's abstract) W91-02191

ENZYME-LINKED IMMUNOSORBENT ASSAY COMPARED WITH GAS CHROMA-TOGRAPHY/MASS SPECTROMETRY FOR THE DETERMINATION OF TRIAZINE HER-BICIDES IN WATER.
Geological Survey, Lawrence, KS. Water Resources Div.

sources Inv.
E. M. Thurman, M. Meyer, M. Pomes, C. A.
Perry, and A. P. Schwab.
Analytical Chemistry ANCHAM, Vol. 62, No. 18,
p 2043-2048, September 15, 1990. 4 fig. 4 tab. 28

Descriptors: \*Chemical analysis, \*Gas chromatography, \*Herbicides, \*Immunoassay, \*Laboratory methods, \*Mass spectrometry, \*Pollutant identifi-

#### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

#### Identification Of Pollutants-Group 5A

cation, \*Triazine herbicides, \*Triazines, \*Water analysis, Comparison studies, ELISA, Enzymes, Metabolites, Organic compounds.

was compared to a gas chromatography/mass spectrometry (GC/MS) procedure for the analysis of triazine herbicides and their metabolites in sur-face water and groundwater. Apparent recoveries from natural water and spiked water by both methrace water and groundwater. Apparent recoveries from natural water and spiked water by both methods were comparable at 0.2-2 micrograms/L. Solid-phase extraction (SPE) was examined also, and recoveries were determined for a suite of triazine herbicides. A significant correlation was obtained between the ELISA and GC/MS method for natural water samples that were extracted by SPE. Because ELISA was developed with an atrazine-like compound as the hapten with conjugation at the 2-position, it was selective for triazines that contained both ethyl and isopropyl side chains. Concentrations for 50% inhibition (ICS0) were as follows: atrazine, 0.4 micrograms/L; ametryne, 0.45 micrograms/L; prometryn and propazine, 0.5 micrograms/L; prometon, 0.7 micrograms/L; simazine and terbutryn, 2.5 micrograms/L; cyanazine, 40 micrograms/L; didealkylatrazine had no response. The combination of screening analysis by ELISA, which requires no sample preparation and works on 160 microliters of sample, and confirmation by GC/MS was designed for rapid, inexpensive analysis of triazine herbicides in water. (Author's abstract) thor's abstract) W91-02192

SHORT-TERM EXPOSURE OF ZOOPLANK-TON TO THE SYNTHETIC PYRETHROID, FENVALERATE, AND ITS EFFECTS ON RATES OF FILTRATION AND ASSIMILA-TION OF THE ALGA, CHLAMYDOMONAS BETNILADIC REINHARDII.

Guelph Univ. (Ontario). Dept. of Environmental Biology. For primary bibliographic entry see Field 5C. W91-02195

ARTIFICIALLY INDUCED METAMORPHOSIS ACETONE IN ACRIS GRYLLUS. Tennessee State Univ., Nashville. Dept. of Biologi-cal Sciences. For primary bibliographic entry see Field 5C. W91-02201

EFFECTS OF ATRAZINE ON FRESHWATER MICROBIAL COMMUNITIES.

Pennsylvania State Univ., University Park. School of Forest Resources. For primary bibliographic entry see Field 5C. W91-02202

RESPONSES OF ZOOPLANKTON AND CHAOBORUS TO TEMEPHOS IN A NATURAL POND AND IN THE LABORATORY. Saint Olaf Coll., Northfield, MN. Dept. of Biol-

For primary bibliographic entry see Field 5C. W91-02203

ASSESSING DETOXIFICATION OF A COM-PLEX HAZARDOUS WASTE, USING THE MI-CROTOX BIOASSAY.

Utah State Univ., Logan. Div. of Environmental Engineering.
For primary bibliographic entry see Field 5E.
W91-02204

METHODS FOR ASSESSING FERTILIZATION AND EMBRYONIC/LARVAL DEVELOPMENT IN TOXICITY TESTS USING THE CALIFOR-NIA MUSSEL (MYTILUS CALIFORNIANUS). California Univ., Bodega Bay. Bodega Marine

G. N. Cherr, J. Shoffner-McGee, and J. M.

Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 9, p 1137-1145, September

1990. 9 fig. 2 tab. 20 ref.

Descriptors: \*Analytical methods, \*Bioassay, \*Bioindicators, \*Embryonic growth stage, \*Mytilus, \*Toxicity, \*Toxicology, DNA, Fertilization, Fluorescence, Larvae, Microscopy, Mussels, Polarization, Pollutant identification.

The fertilized eggs, embryos and larvae of the California mussel (Mytilus californianus) were used to develop methods for assessing fertilization and larval development rates, and for conducting toxicity tests in standard exposure chambers and small volume (3 ml) chambers. Because the sperm/egg ratio resulting in high monospermic fertilization rates varied among females, the 'optimal' ratio for each female was predetermined in an aliquot of eggs prior to fertilizing the entire batch for bioassay use. The fluorescent DNA probe Hoechst 33342 was used to rapidly differentiate unfertilized, monospermic and polyspermic eggs. Following 33342 was used to rapidly differentiate unfertilized, monospermic and polyspermic eggs. Following fertilization of entire batches of eggs based on the predetermined sperm/egg ratio, monospermic fertilization rates of >90% were readily achieved. Fertilized embryos were then used in bioassays conducted in beakers of tissue-culture chamber slides (mini chambers), which could be viewed directly on the microscope. The response of the embryos and larvae to the metabolic inhibitor sodium azide was assessed in both types of test chambers. At 96 h postinsemination at 12 degrees, veliger or nonveliger larvae were assessed using polarization microscopy to determine the presence veliger or nonveliger larvae were assessed using polarization microscopy to determine the presence or absence of a complete shell. No significant difference in the response to sodium azide was detected between the beakers and mini chambers. M. californianus is suitable for static embryo/larval toxicity tests, and small volume chambers allow successful larval development and eliminate the need for subsampling of larger test chambers. The value of assessing fertilization rates prior to conducting the bioassay, and an improved method for examining larval shell development using polarization microscopy were demonstrated. (Author's abstract) stract) W91-02212

POPULATION-SPECIFIC TOXICITY RE-SPONSES BY THE FRESHWATER OLIGO-CHAETE, STYLODRILUS HERINGIANUS, IN NATURAL LAKE MICHIGAN SEDIMENTS.

National Oceanic and Atmospheric Administra-tion, Ann Arbor, MI. Great Lakes Environmental Research Lab.

For primary bibliographic entry see Field 5C. W91-02213

RAINBOW TROUT LIVER ACTIVATION SYSTEMS WITH THE AMES MUTAGENICITY TEST

TEST.
National Fisheries Contaminant Research Center,
Columbia, MO.
B. T. Johnson.
Environmental
Toxicology and Chemistry

Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 9, p 1183-1192, September 1990. 3 fig, 6 tab, 41 ref.

Descriptors: \*Ames test, \*Genotoxicity, \*Liver, \*Mutagenicity, \*Pollutant identification, \*Toxicology, \*Trout, Animal metabolism, Bioassay, Cytochromes, Enzymes, Laboratory methods, Metabolites, Mutagens, Salmonella, Temperature effects. fects.

A poikilothermic metabolic activation system developed from liver homogenate of rainbow trout (Oncorhynchus mykiss, formerly Salmo gairdneri) was used in the Ames Salmonella/Mammalian Microsome Mutagenicity Test. Postmitochondrial fractions (S9) mediated four model promutagens: 2-aminoanthracene (2AA), 2-aminofluorene (2AF), benzo(alpha)pyrene (BaP), and 3-methylcholanthrene (3MC). These promutagens require two different exogenous metabolic activation routes to form mutagens with Salmonella TA98 and TA100. The enzymatic activity of trout S9 was cytochome P-450-like; it was heat labile and oxygen-dependent and cofactor-dependent. Preincubation temperature significantly influenced the sensitivity of the fish-activated Ames test. Bacterial mutagenesis with trout activation significantly decreased as A poikilothermic metabolic activation system de-

preincubation temperature increased; the optimum preincubation temperature increased; the optimum \$59 activation temperature range for trout was 10 to 15 degrees compared with 37 degrees for the rat. The liquid-preincubation test was best adapted to the trout polikilothermic activation system; it was significantly more sensitive than the plate-incorporation test in detecting histidine revertants. The \$9 ration test in detecting histidine revertants. The S9 activity of trout and rat was qualitatively similar in the Ames test; that is, both fractions metabolically activated ZAA, ZAF, BaP and 3MC to produce bacterial mutagenesis with Salmonella TA98 and TA100. The use of this ecologically relevant exogenous activation system in the short-term predictive genotoxicity testing of freshwater ecosystems is helpful in the assessment of potential hazards of chemical contaminants on fishery resources. (Author's abstract) thor's abstract)

COMPARATIVE EVALUATION OF FIVE TOXICITY TESTS WITH SEDIMENTS FROM SAN FRANCISCO BAY AND TOMALES BAY, CALI-

National Ocean Service, Seattle, WA. Ocean As-

E. R. Long, M. F. Buchman, S. M. Bay, R. J. Breteler, and R. S. Carr.

Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 9, p 1193-1214, September 1990. 13 tab, 38 ref.

Descriptors: \*Mutagenicity, \*San Francisco Bay, \*Sediment contamination, \*Toxicity, \*Toxicology, \*Water pollution effects, Amphipods, Chemical analysis, Coastal environment, Comparison studies, analysis, Cossial environment, Comparison students, Echinoderms, Embryonic growth stage, Genotoxi-city, Hydrocarbons, Marine environment, Mussels, Mytilus, Organic carbon, Pollutant identification, Polychaetes, Sediment analysis, Trace metals.

The relative sensitivity, analytical precision, discriminatory power and concordance among endpoints with sediment chemistry were compared among five sediment toxicity tests. The tests were performed with aliquots of 15 composited, homogenized sediment samples. Survival and a variety of published attacks of the series of t entrormed with aliquots of 15 composited, homogenized sediment samples. Survival and a variety of sublethal endpoints were determined in tests performed with the amphipods Rhepoxynius abronius and Ampelisca abdita, embryos of the urchin Strongylocentro-tus purpuratus and the polychaete Dinophilus gyrociliatus. Each sample was also tested for trace metal and organic compound concentrations, organic carbon content and texture. Two of the five tests (survival among M. edulis and survival among M. edulis and survival among M. edulis and survival among A. abronius) were highly ensitive to the samples and had relatively high precision, but the results were correlated most highly with sedimentological variables. One of the tests (survival among A. abdita) was relatively insensitive, but the results were highly correlated with only the concentrations of toxic chemicals. The test with S. purpuratus indicated mutagenicity in several samples that had high hydrocarbon concentrations. The test of pore water with D. gyrociliatus was intermediate in sensitivity and precision and not pies that had migh hydrocarroin concentrations. The test of pore water with D. gyrociliatus was intermediate in sensitivity and precision and not correlated highly with the results from other tests. (Author's abstract) W91-02218

COMPARISON OF QUARTER-HOURLY ON-LINE DYNAMIC HEADSPACE ANALYSIS TO PURGE-AND-TRAP ANALYSIS OF VARYING VOLATILE ORGANIC COMPOUNDS IN DRINKING WATER SOURCES.

Drexel Univ., Philadelphia, PA. Dept. of Chemis-

G. Schnable, B. Dussert, I. H. Suffet, and C. D. Hertz. Journal of Chromatography JOCRAM, Vol. 513, p 47-54, July 27, 1990. 6 fig, 1 tab, 7 ref.

Descriptors: \*Analytical methods, \*Monitoring, \*Pollutant identification, \*Volatile organic compounds, \*Water supply, Chemical analysis, Comparison studies, Electronic equipment, Gas chromatography, Water conveyance.

The temporal monitoring of volatile organic com-pounds (VOCs) in water sources is important be-

#### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

#### **Group 5A—Identification Of Pollutants**

cause of contamination and the transport of contaminants. This project was the first application of quarter-hourly on-line headspace analysis for monitoring VOC concentrations in surface and ground waters, for extended periods of time. A Siemens P101 dynamic headspace analyzer was refined, and quality assurance was developed for quarter-hourly analyses. Hourly comparisons were made to on-line purge-and-trap analysis and to purge-and-trap analysis after sample preservation and storage. Variations in VOC concentrations of 6047% biweckly, 2229 daily, 97% hourly, and 35% quarter-hourly were observable, with the 15-min cycle of the dynamic headspace analysis. The headspace analyzer had superior retention time stability, required less maintenance, and had 1/4 the analysis time as a typical purge-and-trap-gas chromatography system used for hourly comparisons. (Author's abstract)

PERIPHYTON AS INDICATOR OF THE RESERVOIR WATER QUALITY: III, BIOMONITORING TECHNIQUES.

Prague Dept. of Water Technology and Environmental Engineering (Czechoslovakia).

A. Sladeckova.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 775-782, 1990. 2 fig, 30 ref.

Descriptors: "Analytical methods, "Bioassay, "Bioindicators, "Limnology, "Monitoring, "Peri-phyton, "Reservoirs, "Water quality, Algae, Ciliates, Diatoms, Organic compounds, Protozoa, Trace metals.

Periphyton bioassays on species, community, and microcosm levels conducted in situ or in the laboratory using field-collected water can be used for the biomonitoring of pollution, eutrophication, and toxic effects of the water quality of reservoirs and their tributaries. Such assays measure important environmental stress factors in natural localities. (1) On the species level, the algae Stigeoclonium subsecundum and Cladophora glomerata and the clitate Vorticella convallaria have been shown to be good biological monitors of water pollution. (2) On the community level, diatoms have been used as representatives of the algal components of the periphyton community, mostly for the monitoring of organic pollution, nutrient enrichment, and bioaccumulation of trace metals. Protozoan community structure and colonization dynamics have also been used for testing water pollutants. The majority of procedures using the entire periphyton community to monitor water quality are based on the exposure of artificial substrates. The aim is to provide comparable conditions for periphyton colonization in localities with variable or nonexistent natural substrata. (3) At the microcosm level, experimental units are used to contain important components and to exhibit important processes occurring in a whole ecosystem. Designed mostly for simulating the conditions in flowing water, they are also appropriate for testing water quality in reservoir tributaries. The choice of an appropriate bioassay technique or of the best combination of several methods will be dictated by the specific data requirements of the study, by the level of environmental control desired and by the investigator's resources and equipment. (Sand-PPTT)

WATER QUALITY IN CZECHOSLOVAK WATER-SUPPLY IMPOUNDMENTS. Prague Dept. of Water Technology and Environmental Engineering (Czechoslovakia). For primary bibliographic entry see Field 2H. W91-02386

CLASSIFICATION OF SOME RESERVOIRS IN SR SERBIA (SFR YUGOSLAVIA) BASED ON ANALYSIS OF PLANKTON SPECIES AS INDI-CATORS OF TROPHIC CONDITIONS. Institute for Biological Research, Belgrade (Yugostavia). For primary bibliographic entry see Field 2H. W91-02388

WATER QUALITY OF SOME RESERVOIRS.

Vyzkumny Ustav Vodohospodarsky, Prague (Czechoslovakia).
D. Matulova.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 861-867, 1990. 1 fig, 3 tab, 4 ref.

Descriptors: \*Algae, \*Bacteria, \*Bioassay, \*Pollution index, \*Reservoirs, \*Water quality, Chlamydomonas, Czechoslovakia, Escherichia coli, Nitrates, Phosphates, Scenedesmus, Serratia.

In evaluating the water quality of reservoirs, in addition to physical and chemical analyses biological methods have become increasingly important. Several biological procedures were used in a study of the water quality of six Czechoslovakian reservoirs. The results were compared with physical and chemical data to determine the water quality at the chosen localities and to evaluate the results obtained from the methodological points of view and the importance of individual factors which affect the water quality. The ecological procedures included saprobity zones determination, based on biological analyses, and determination of total numbers of bacteria multiplying at 37 C and 20 C and the number of coliforms. Experimental biological procedures (physiological tests) included bioassays with algae (Scenedesmus quadricauda and Chlamydomonas eugametos) and bioassays with algae (Scenedesmus quadricauda and Chlamydomonas eugametos) and bioassays with bacteria (Escherichia coli and Serratia marcescens). The following results were obtained: (1) the physiological tests with both algae depended on the contents of phosphates in the samples examined; (3) phosphorus was proved as the limiting factor at the investigated localities; (4) the results of the physiological tests with algae were not closely related to the contents of nitrates in the samples; (5) the mutual relationship between the results of bioassays with algae and bacteria was not significant; (6) the results of the physiological tests with both bacteria were very similar and were in good conformity with the contents of nitrates; (7) the saprobic index according to Sladecek at the investigated localities compared with the chemical and physical data, and the results of physiological tests applied varied less. (Sand-PTT)

SOLVENT SUBLATION OF HEXACHLORO-BUTADIENE AND 2,4,6-TRICHLORO-

PHENOL.
National Tsing Hua Univ., Hsinchu (Taiwan).
Dept. of Chemistry.
For primary bibliographic entry see Field 5D.
W91-02403

SIMPLE MEMBRANE FILTER METHOD TO CONCENTRATE AND ENUMERATE MALE-SPECIFIC RNA COLIPHAGES,

North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.

M. D. Sobsey, K. J. Schwab, and T. R. Handzel.
Journal of the American Water Works Association
JAWWA5, Vol. 82, No. 9, p 52-59, September
1990. 2 fig, 7 tab, 25 ref.

Descriptors: \*Bacteriophage, \*Bioindicators, \*Enteroviruses, \*Laboratory methods, \*Membrane filters, \*Pollutant identification, \*Water treatment, Disinfection, Groundwater, RNA coliphages, Surface Water Treatment Rule, Viruses, Water quality, Water quality standards.

Because of concerns about viruses and other microbial contaminants in drinking water, the US EPA recently promulgated the Surface Water Treatment Rule, which requires filtration and disinfection to achieve a 99.99% virus reduction. A groundwater disinfection rule targeted at controling viruses and other microbial pathogens through disinfection is now in preparation. The development of treatment requirements to control viruses in drinking water is based, in part, on the inability to define a practical virus standard or develop a technically feasible, reliable, inexpensive, and rapid virus monitoring strategy or virus indicator system. Recent research suggests that male-specific (F-specific) RNA coliphages, a group of small, icosahedral bacteriophages infecting male strains of Escherichia coli, may fulfill many of the essen-

tial requirements of a viral indicator. A simple membrane filter method for concentrating and enumerating F-specific coliphages in raw and finished drinking water was developed with a view to using these phages as a viral indicator. F-specific coliphages were enumerated by plaque assays on a specially constructed host of Salmonella typhimurium that is resistant to nalidixic acid and kanamycin and contains an E. coli pilasmid responsible for E. coli pili production and, thus, susceptibility to infection by F-specific coliphages. The method developed was field-tested by determining the concentrations of F-specific coliphages in several source waters and comparing them with concentrations of fecal indicator bacteria. The results suggest that the new membrane filter method for enumerating F-specific coliphages should be useful for assessing fecal contamination of natural and treated waters. Additional studies are needed to determine whether these coliphages are reliable indicators of enteric viruses in water. (Mertz-PTT) W91-02416

LIQUID CHROMATOGRAPHY-MASS SPECTROMETRY: AN EMERGING TECHNOLOGY FOR NONVOLATILE COMPOUNDS.

Christon Agency, Cincinnati, OH. Chemistry Research Div.
W. L. Budde, T. D. Behymer, T. A. Bellar, and J.

Journal of the American Water Works Association JAWWA5, Vol. 82, No. 9, p 60-65, September 1990. 10 fig, 1 tab, 18 ref.

Descriptors: "Analytical techniques, "Chemical analysis, "High performance liquid chromatography, "Liquid chromatography, "Mass spectrometry, "Organic compounds, "Pollutant identification, "Water analysis, Detection limits, Drinking water, Particle beam, Regulations, Separation techniques.

Most currently regulated organic compounds found in drinking water are amenable to separation and measurement by gas chromatography. A new generation of compounds being proposed for regulation includes some that are not amenable to separation and measurement with this technique. The emerging analytical technology of liquid chromatography-mass spectometry is considered a likely candidate for the separation and measurement of nonvolatile compounds in drinking water. Highpressure liquid chromatography-particle-beammass spectrometry shows promise as broad-spectrum analytical technique applicable to the determination of a variety of nonvolatile compounds in drinking water and other environmental samples. The combination of precise retention times, electron ionization mass spectra, and isotope distribution patterns from compounds containing naturally occurring isotopes gives excellent information for the unequivocal identification of target and unexpected analytes. The precision, calibration, and instrument detection limits obtained with high pressure liquid chromatography-particle-beammass spectrometry are encouraging and suggest that it will be possible to develop a broad-spectrum analytical method. Particle-beam liquid chromatography-mass spectrometry technology is relatively new, and substantial improvements in systems and performance are expected during the early 1990s. (Mertz-PTT)

COMPARISON OF THE ZINC SULFATE AND IMMUNOFLUORESCENCE TECHNIQUES FOR DETECTING GIARDIA AND CRYPTO-SPORIDIUM.

American Water Works Service Co., Inc., Belleville, IL. Belleville Lab.
M. W. LeChevallier, T. M. Trok, M. O. Burns, and

M. W. LeChevallier, T. M. Trok, M. O. Burns, an R. G. Lee.

Journal of the American Water Works Association JAWWA5, Vol. 82, No. 9, p 75-82, September 1990. 7 tab, 45 ref.

Descriptors: \*Analytical techniques, \*Cryptosporidium, \*Giardia, \*Human pathogens, \*Parasites, \*Pollutant identification, \*Protozoa, \*Water treatment, Fluorescence, Immunofluorescence, Surface

#### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

#### Identification Of Pollutants-Group 5A

Water Treatment Rule, Water quality control, Water quality standards. Zinc sulfate method.

Epidemiological studies have shown that Giardia lamblia is widespread, with infection rates among individuals in North America ranging from 1.5-22%. Giardia has been reported to be present in 10-28% of lakes, rivers, and creeks tested. The coccidian protozoan, Cryptosporidium, was not recognized in humans until 1976. In recent years this parseries her been included in executives. this parasite has been isolated in stools at a rate of up to 23%. Cryptosporidium appears to be widely distributed in the aquatic environment. An immunofluorescence method for the simultaneous detecofluorescence method for the simultaneous detection of Giardia and Cryptosporidium in water was compared with the zinc sulfate flotation and Lugol's iodine method in surface water samples collected in western Pennsylvania. The results showed that the immunofluorescence technique detected approximately 12 times more Giardia cysts in surface water samples than the zinc sulfate method. In addition, Cryptosporidium was detected in several samples. Application of the immunofluorescence procedure for surface waters detected Giardia at levels as high as 690 cysts/100 gallon at this level, utilization of the 99% filtration criteria proposed in the Surface Water Treatment Rule would still result in about 7 Giardia cysts/100 gallon of filtered water. The results are significant would still result in about / Giardia cysts/100 gallon of filtered water. The results are significant because they represent levels not detected using the zinc sulfate flotation technique. These data suggest that operators of treatment plants with suggest that operators of treatment plants with poor source-water quality should pay special atten-tion to flocculation, coagulation, and filtration processes to optimize parasite removal. (Mertz-PTT) W91-02419

ASSESSING DEFINED-SUBSTRATE TECH-NOLOGY FOR MEETING MONITORING RE-QUIREMENTS OF THE TOTAL COLIFORM

Illinois State Environmental Protection Agency, Springfield. M. M. Katamay

JAWWA5, Vol. 82, No. 9, p 83-87, September 1990. 2 tab, 23 ref.

Descriptors: \*Analytical techniques, \*Coliforms, \*Pollutant identification, \*Water quality manage-ment, \*Water quality standards, \*Water treatment, Bacteria, Defined-substrate technology, Drinking water standards, Illinois, Membrane filter proce-dure, Water analysis, Water law, Water sampling.

The Illinois Environmental Protection Agency is The Illinois Environmental Protection Agency is responsible for drinking water analyses for approximately 2,200 public water utilities serving more than half the state's population. The recently developed defined-substrate technology (commercially known as Coillert), which simultaneously enumerates both total coliforms and Escherichia coli and does not require confirmatory tests, was compared in this geographic area with the membrane filter procedure from Standard Methods. Overall there were no differences between mem-Overall, there were no differences between mem-brane filter and defined-substrate technology. Subbrane filter and defined-substrate technology. Sub-cultures of positive defined-substrate technology tubes demonstrated this technology's specificity. Yellow (total coliform-positive) tubes yielded spe-cies consistent with total coliforms, and fluorescent (E.coli-positive) tubes contained E. coli. The de-fined-substrate system was easy to use and is com-patible with new drinking water regulations that will increase monitoring and resampling require-ments, mandate a fecal indicator (either an E. coli-cer feed edifferen seakupia) and tears a maximum ments, mandate a fecal indicator (either an E. coli or fecal coliform analysis), and use a maximum contaminant level in the frequency-of-occurrence mode. Defined-substrate technology also has several important advantages for state regulators, including its ability to help utilities comply with new transportation and storage requirements. (Author's abstract)
W91-02420

TOXICITY TEST PROCEDURES FOR HYA-LELLA AZTECA, AND CHRONIC TOXICITY OF CADMIUM AND PENTACHLORO-PHENOL TO H. AZTECA, GAMMARUS FAS-CIATUS, AND DAPHNIA MAGNA.

Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.
U. Borgmann, K. M. Ralph, and W. P. Norwood. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 5, p 756-764, September 1989. 4 fig, 6 tab, 34 ref.

Descriptors: \*Amphipods, \*Bioindicators, \*Cadmium, \*Chronic toxicity, \*Pentachlorophenol, \*Toxicity, \*Toxicology, \*Water pollution effects, \*Waterfleas, Aquatic animals, Aquatic environment, Benthic environment, Cultures, Culturing techniques, Daphnia, Gammarus, Great Lakes, Growth, Hyalella, Life cycles, Mortality, Sub-

Survival, growth, and reproduction of Hyalella azteca were determined under various test conditions. Reproduction by a cohort begins when the amphipods are 5 to 6 weeks old, peaks at 8 to 12 weeks, and then declines due to continuing adult mortality. Full life-cycle tests can be completed in 12 to 14 weeks at 25 C. Reproduction is poor when only artificial plastic substrate is provided. A substrate of cotton gauge results in dramatic improvements in both reproduction and growth. Better reproduction can be obtained by culturing the amphipods in some sediments, but this makes weekly enumeration difficult. Increased mortality during chronic exposure to cadmium was observed at 1 microgram/L for H. azteca and 3.2 microgram/L for Gammarus fasciatus. Reproduction during longer exposure was not reduced at concentrations lower than those causing increased mortality longer exposure was not reduced at concentrations lower than those causing increased mortality within six weeks. Chronic toxicity of pentachlorophenol was observed at 100 micrograms/L for both species. Chronic toxicity to Daphnia magna was similar to that of the amphipods for cadmium, but lower for pentachlorophenol. Amphipods are at least as sensitive as Daphnia to a variety of toxicants during chronic exposure. (Author's abstract) stract) W91-02444

ACUTE TOXICITY OF INDUSTRIAL SURFACTANTS TO MYSIDOPSIS BAHIA.

AWARE, Inc., Nashville, TN.
For primary bibliographic entry see Field 5C.
W91-02445

BINDING OF TRIAZINE HERBICIDES TO ANTIBODIES IN ANHYDROUS ORGANIC

ANTIBODIES IN ANHYDROUS ORGANIC SOLVENTS.
Gesellschaft fuer Biotechnologische Forschung m.b.H., Brunswick (Germany, F.R.). Dept. of Enzyme Technology.
W. Stocklein, A. Gebbert, and R. D. Schmid. Analytical Letters ANALBP, Vol. 23, No. 8, p 1465-1476, August 1990. 1 fig. 2 tab, 13 ref.

Descriptors: \*Analytical methods, \*Drinking water, \*Immunoassay, \*Pesticides, \*Pollutant identification, \*Water analysis, Antibodies, Atrazine, Detection limits, Organic solvents, Propazine, Simazine, Toluene, Triazine herbicides.

Preconcentration of pesticides in drinking water by extraction or elution from columns with organic solvents has been used to improve detection limits in various analytical methods. To assess the applicability of preconcentration in organic solvents to immunochemical techniques, the binding of atrazine and an atrazine derivative dissolved in various zine and an atrazine derivative dissolved in various nonpolar organic solvents to immobilized polyclonal antibodies was studied. The antibodies immobilized onto immunodyne membranes were stable in chloroform and in buffer for at least 65 h at room temperature. The apparent binding affinity was lower in the five solvents tested than in buffer, and showed a correlation with the polarities of the solvents and with the solubilities of the haptens in solvents and with the solubilities of the haptens in the solvents. An increase in the antibody-hapten binding specificity by the use of toluene as the solvent for atrazine, propazine and simazine was observed. (Mackeen-PTT) W91-02512

DETERMINATION OF COBALT BY ADSORP-TIVE STRIPPING VOLTAMMETRY USING

COBALTUD-NIOXIME-NITRITE CATALYTIC

Academy of Mining and Metallurgy, Krakow (Poland). Inst. of Material Science.

(Foliato) Institution of the American Analytical Letters Anal.BP, Vol. 23, No. 8, p 1487-1503, August 1990. 4 fig. 1 tab, 35 ref.

Descriptors: \*Analytical methods, \*Cobalt, \*Pol-Descriptors: "Analytical metricus, "Coolif, For-lutant identification, "Water analysis, Adsorption, Detection limits, Drinking water, Natural waters, Nickel, Voltammetry, Water pollution, Water sampling. Zinc.

A differential pulse adsorptive voltammetric method was developed for cobalt determination with a detection limit of 120 pM (100 sec preconcentration). The preconcentration of Co(II)-nioxime complex during the adsorption step and the utilization of catalytic effect during the reduction of Co(II)-nioxime complex provides present and the conference of Co(II)-nioxime complex provides the present and the conference of Co(II)-nioxime complex provides the present and the conference of Co(II)-nioxime complex provides the present and the conference of th utilization of catalytic effect during the reduction of Co(II)-nioxime complex provide great enhancement of cobalt voltammetric response. The ammonia buffer solution containing nioxime and nitrite is suitable for the adsorptive voltammetric determination of nanomolar cobalt concentrations in the presence of 1000-fold excess of nickel and 10,000-fold excess of zinc. The sensitivity and selectivity of the proposed method are significantly higher than those of the well-known adsorptive voltammetric method with dimethylglyoxime. The method has been tested for the determination of Co in river, canal and tap water samples. (Author's abstract) W91-02513

SAFETY AND EFFICACY OF FOOD PROCESSING SLUDGES AS ANIMAL FEED: CHEMICAL CHARACTERIZATION. For primary bibliographic entry see Field 5E. W91-02542

FAST DETERMINATION OF THE BIODEGRA-BILITY OF ORGANIC COMPOUNDS IN A LABORATORY-TRICKLING-FILTER (RASCHE BESTIMMUNG DES BIOABBAUS ORGAN-ISCHER STOFFE IN EINEM LABOR-TROPF-

Eidgenoessische Materialpruefungs- und Versuch-sanstalt fuer Industrie, Bauwesen und Gewerbe, St. Gall (Switzerland). For primary bibliographic entry see Field 5D. W91-02544

ANALYTICAL PROPERTIES OF 4,4'-BIAZO-BENZENEDIAZOAMINOBENZENE AND ITS APPLICATIONS IN SPECTROPHOTOMETRY. China National Environmental Monitoring Centre,

Beijing. F. Wei, W. Jiang, E. Teng, Y. Zhu, and J. Liu. Analytical Letters ANALBP, Vol. 23, No. 7, p 1181-1190, July 1990. 4 fig, 3 tab, 7 ref.

Descriptors: \*Azo dyes, \*Chelating agents, \*Chemical analysis, \*Colorimetry, \*Heavy metals, \*Metal complexes, \*Pollutant identification, \*Spectrophotometry, \*Water analysis, Analytical methods, Cadmium, Chemical properties, Reagents, Water pollution.

In the past, chelating ligands with auxochromic groups at the para-position of benzenediazoaminoa-zobenzene have been studied as agents for the zooenzene nave been suuleu as agents for the spectrophotometric determination of transition metal ions. In this study, 4,4-biazobenzene diazoamino benzene was synthesized from para-aminoazobenzene reacted in nitroso-sulfuric acid medium. Due to the existence of a strong auxochromic group (p-benzeneazo) in the molecule, the reagent has intense color reactions with some transition metal ions. The reagent is insoluble in water, soluble in organic solvents such as acetone, chloro-form, benzene, carbon tetrachloride, and ethanol. In neutral and alkaline media, the reagent solution is yellow and stable for at least a month. In the presence of Triton X-100 and sodium tetraborate presence of I filton A-100 and sodium tetraporate solution, the reagent reacted with mercury(II), nickel(II), cadmium(II), copper(II), zinc(II), cobalt(II), palladium(II) and silver(I) to form stable, highly sensitive complexes, exhibiting a red

#### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 5A-Identification Of Pollutants

color. Other metal ions were complexed, but these did not generate a detectable color. Molar absorptivities were 180,000 L/mol/cm at 515 nm for mercury, 200,000 L/mol/cm at 540 nm for nickel, and 180,000 L/mol/cm at 526 nm for cadmium. The reagent was used for spectrophotometric determination of cadmium in industrial waste waters from a smelter, battery works, and an alkali works. Results agree well with those of atomic absorption. spectrophotometry. Interference from other metal ions can be eliminated by extraction separation.

DETERMINATION OF TRACE AMOUNTS OF ACETALDEHYDE USING A NOVEL CHEMI-LUMINESCENCE REACTION.

University of Science and Technology of China, Hefei. Dept. of Applied Chemistry. For primary bibliographic entry see Field 7B. W91-02549

STRUCTURE OF AN ANHYDRIDE RELATED TO A MUTAGENIC COMPONENT OF DRINK-ING WATER, 3-CHLORO-4-(DICHLORO-METHYL)-5-HYDROXY-2/5H)-FURANONE. State Univ. of New York at Syracuse. Coll. of Environmental Science and Forestry. R. T. LaLonde, H. Perakyla, Y. Ishiguro, J.

R. 1. LaLonde, H. Perakyia, Y. Isinguro, J. Clardy, and L. S. Brinen. Chemical Research in Toxicology CRTOEC, Vol. 3, No. 6, p. 404-405, September/October 1990. 1 fig. 1 tab, 12 ref. USGS Award 14-08-0001-G1498.

\*Crystallography, Descriptors: "Crystatiography, "Distinction," "Genotoxicity, "Molecular structure, "Mutagens, "Pollutant identification, "Structure-activity rela-tionships, "Water treatment, Chemical interactions, Chemical properties, Chlorination, Pulp wastes, Wastewater pollution.

3-Chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-Furning + (ucmorometry); -nydroxy-2(3H)-furanone (MX) is the most potent member of a family of genotoxins resulting from the disinfection of drinking water and the bleaching of wood pulp by chlorination. MX is often a major contributor to the mutagenic activity of drinking waters. It as a direct-acting bacterial mutagen and a mammalian cell clastogen and forms an adduct with DNA.
Unexpectedly, crystals of an MX anhydride were Unexpectedly, crystals of an MX annydride were formed, in the course of unsuccessful attempts to obtain MX in a form appropriate for X-ray crystallography. A crude sample of MX was flash-chromatographed twice and the colorless oil obtained stored at -18 C for 6 months. The resulting crystalline solid was recrystallized from n-hexane-ether at complementary. Crystall yuser armined by this room temperature. Crystals were examined by thin layer chromatography, infrared analysis, and (1)H layer chromatography, infrared analysis, and (1)H NMR (nuclear magnetic resonance). From a com-puter-generated perspective drawing of the final X-ray model (one enantiomer of the racemic mix-A-ray model one enamined the raceme interestrict, comparison of the anomeric torsion angles revealed that the crystal lacked the expected molecular of a dl diastereomer. A space-filling molecular model of the X-ray structure illustrated there ular model of the X-ray structure illustrated there is essentially an oxygen-dominated surface, and an opposite, chlorine-dominated surface. There is little doubt that MX's genotoxicity is a manifestation of the compound's electrophilicity; each of the five carbons is an electrophilic site. The anhydride's structure information anticipates a mode of reactivity that could account for MX's mutagenic potency. (VerNooy-PTT) W91-02551

ANALYTICAL APPROACH TO ASSESSMENT OF LONG-TERM EFFECTS OF LOW LEVELS OF CONTAMINANTS IN THE MARINE ENVI-

RONMENT.
Cambridge Univ. (England). Dept. of Zoology.
G. Howells, D. Calamari, J. Gray, and P. G.

Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 8, p 371-375, August 1990. 1 fig, 3 tab.

Descriptors: \*Chronic toxicity, \*Coastal waters, \*Environmental effects, \*Hazard assessment, \*Marine pollution, \*Monitoring, \*Pollutant identification, \*Water pollution effects, Baseline studies, Case studies, Indicators, Long-term planning,

Marine environment, Pollutants, Water pollution control.

Detection of long-term changes due to low level contamination in the coastal and inshore mari environment is very difficult, both because of the complexity and interactive nature of ecosystems, of their variability in time and space, and the absence in most situations of a norm or baseline representin most situations of a norm or baseline representing the pristine, or even the previous state of a particular ecosystem or community. There is also the problem of identifying the nature and source of contamination and the type of exposure. An analytical approach to assessment is proposed and its validity tested by reference to a few cases where there is judged to be strong evidence of biological change in response to a persistent but low level of contamination. A few examples of contaminants have been identified and selected, including nutrients, chlorinated hydrocarbons, tributyl tin. and contamination. A few examples of contaminants have been identified and selected, including nutrients, chlorinated hydrocarbons, tributyl tin, and hydrocarbons. In these four examples there is aufficient body of quantitative and qualitative data where the cause of damage is indisputable and where the agent is present in low and persistent concentrations. They represent a diversity of causal agents and of biological responses, i.e., primary productivity, reproduction, growth and nonspecific biological responses. These examples illustrate the kinds of information needed for assessment leading to control and monitoring, and where early warning signals can be identified and included in a monitoring program. A major challenge is to be able to document contaminant induced change against the highly variable and complex pattern of natural conditions. A second challenge is to detect change in an imperfectly understood marine ecosystem. In addition, improvement and calibration of ecotoxicological methods for detecting chemically inducted changes is needed. A detailed evaluation of a wider range of data to substantiate and verify the thesis that long-term biological changes can be attributed to low-levels of contamination is also required. (VerNooy-PTT) W91-02554

FUCUS VESICULOSUS AS AN INDICATOR OF HEAVY METAL AVAILABILITY IN A FISH FARM RECIPIENT IN THE NORTHERN BALTIC SEA. Abo Akademi, Turku (Finland). Dept. of Biology. O. Ronnberg, K. Adjers, C. Ruokolahti, and M.

Bondestam. Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 8, p 388-392, August 1990. 5 fig, 20 ref.

Descriptors: \*Algae, \*Baltic Sea, \*Bioindicators, \*Coastal waters, \*Finland, \*Fish farming, \*Fucus, \*Heavy metals, \*Path of pollutants, \*Water pollution sources, Aquaculture, Copper, Iron, Manganese, Marine pollution, Seasonal variation, Trout, Zinc.

In recent years, cage farming of rainbow trout has been a strongly expanding industry in Finnish coastal waters, with 1988 production exceeding 12,700 tons. Contents of zinc (Zn), manganese (Mn), and copper (Cu) in the brown seaweed Fucus vesiculosus L. were studied between May 1987 and April 1988 near a fish farm in the Aland archipelage, southwest Finland. Measurements 1987 and April 1988 near a fish farm in the Aland archipelago, southwest Finland. Measurements were made on samples from naturally growing Fucus specimens from an unaffected reference locality and from specimens transplanted to the vicinity of the farm (50, 200 and 700 m away). At the unaffected locality there was a clear seasonal variation in contents of the studied metals in growing tips of Fucus specimens. Significantly higher contents of Fe and Cu were measured in autumn and winter in specimens transplanted close to the farm. In summer, the contents of Mn and Zn showed an increasing tendency with decreasing distance to increasing tendency with decreasing distance to the farm. Results indicate marked seasonal variations in metal contents and the applicability of Fucus vesiculosus as an indicator of the availability rucus vesicuiosus as an indicator of the availability of Zn, Mn and Cu in fish farm recipients in the Baltic Sea. The irregular variation in the concentration of iron makes Fucus less useable as an indicator of iron availability. (VerNooy-PTT) W91-02560

INFORMATION COLLECTION REQUEST FOR: NATIONAL PRIMARY DRINKING

WATER REGULATIONS FOR INORGANIC CHEMICALS.

Miller (Wade) Associates, Inc., Arlington, VA. For primary bibliographic entry see Field 7B. W91-02602

GUIDELINES FOR PHYSICAL AND BIOLOGI-CAL MONITORING OF AQUATIC DREDGED MATERIAL DISPOSAL SITES.

Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab. T. J. Fredette, D. A. Nelson, J. E. Clausner, and F.

J. Anders. Available from the National Technical Information Service, Springfield, VA 22161. Technical Report No. D-90-12. September, 1990. 46 p, 7 fig, 2 tab, 18

Descriptors: \*Data acquisition, \*Disposal sites, \*Dredging wastes, \*Monitoring, \*Standards, \*Waste disposal, \*Water quality, Bioassay, Measuring instruments, Satellite technology, Water quality control.

A preliminary set of guidelines are given for moni-toring aquatic, uncontaminated dredged material disposal sites, and are intended to serve as a 'worktoring aquatic, uncontaminated dredged material disposal sites, and are intended to serve as a "working' document that can be periodically improved as experience dictates. Emphasis is placed on: (1) the establishment of concise objectives and hypotheses; (2) the use of multidisciplinary approaches for developing monitoring programs; and (3) and the provision of results that are relevant and useful to site managers. A "tiered" step-wise procedure which can be used when developing a monitoring program is presented, along with a summary of the basic tools and techniques for biological (such as bioassays with fish, shellfish, benthic infauna, and submergent vegetation) and physical analyses (such as satellites, bathymeters, fathometers, sediment samplers, sediment-profiling cameras, and wave meters). Ideally, monitoring of open water dredged material disposal sites should be prospective. Observations or measurements are taken to determine if site conditions conform to defined conditions. Monitoring can then focus on the detection of changes in specific conditions rather than identifying any or all detectable changes. A monitoring program should be multi-tiered, with than identifying any or all detectable changes. A monitoring program should be multi-tiered, with each level having its own predetermined environmental threshold, hypothesis, sampling design, and management options should the threshold be exceeded. (Lantz-PTT)

APPLICATION OF A SIMPLE SHORT-TERM BIOASSAY FOR THE IDENTIFICATION OF GENOTOXINS FROM HAZARDOUS WASTES. Environmental Health Research and Testing, Inc.,

Research Triangle Park, NC. S. S. Sandhu, and G. N. Acedo.

S. S. Sandhu, and G. N. Acedo. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-224570. Price codes: AO3 in paper copy, AO1 in micro-fiche. Report No. EPA/600/D-89/099. 1989. 12p, 2 fig, 4 tab.

Descriptors: \*Aquatic plants, \*Bioassay, \*Bioindicators, \*Mutagenicity, \*Pollutant identification, \*Toxicity, \*Water pollution effects, Arabidopsis, Economic aspects, Industrial wastes, Monitoring, Testing procedures, Tradescantia. Zea.

The proper disposal of hazardous wastes currently generated and clean up of waste disposal sites of the past are challenges facing regulatory agencies in the industrialized nations. The estimation of levels of toxicity is an essential step in prioritizing industrial effluents and solid wastes for treatment and disposal. A number of short-term bioassays has been developed to supplement information from chemical analysis for evaluating the potential of chemical complex mixtures to induce adverse human health effects and environmental contamiation. Among these bioassays, plant test systems provide simple, inexpensive, and rapid means of evaluating toxic effects of industrial wastes based on multimedia exposure. Two such assays, Tradescantia paludosa and Zea mays, have been used for monitoring the genotoxic effects of ambient air,

#### Identification Of Pollutants-Group 5A

municipal wastes, industrial effluents, solid wastes, water sediments, and pesticides. The Arabidopsis embryo assay was used to evaluate the mutagenicity of complex environmental mixtures including industrial effluents and sludges. The industrial waste samples were tested as either unextracted or as dichloromethane aqueous extracts. All methylene chloride-extracted samples were positive for mutagenicity; however, dose-related response was not observed for these extracts. For the aqueous extracts the NP3 and N-Hg recovery sludge samples showed dose-related mutagenic response although the mutagenicity values were much lower than that of NP2. The primary advantages of the plant bioassays are their simplicity, cost effectiveness, and utility in assessing simultaneous multimedia exposure. (Author's abstract)

INSTALLATION OF A MULTIPORT GROUND-WATER SAMPLING SYSTEM IN THE 300 AREA.

Battelle Pacific Northwest Labs., Richland, WA.

T. J. Gil

T. J. Gilmore. Available from the National Technical Information Service, Springfield, VA 22161, as DE89-014794. Price codes: A03 in paper copy, A01 in microfiche. June 1989, 34p, 8 fig. 1 tab, 4 ref, append. DOE Contract No. DE-AC06-76RLO-1830.

Descriptors: \*Groundwater pollution, \*Ground-water sampling, \*Monitoring, \*Path of pollutants, \*Sampling, \*Water sampling, Design criteria, Han-ford Site, Hydrogeology, Wells.

In 1988, the Pacific Northwest Laboratory installed a multiport groundwater sampling system in well 399-1-2, drilled north of the 300 Area on the Hanford Site in southeastern Washington State. The purpose of installing the multiport system is to evaluate methods of determining the vertical distribution of contaminants and hydraulic heads in groundwater. Well 399-1-20 is adjacent to a cluster of four Resource Conservation and Recovery Act (RCRA) groundwater monitoring wells. This proximity makes it possible to compare sampling intervals and head measurements between the multiport system and the RCRA monitoring wells. Drilling and installation of the multiport system took 42 working days. Six sampling ports were installed in the upper unconfined aquifer at depths of approximately 120, 103, 86, 74, 56, and 44 feet. The locations of the sampling ports were determined by the hydrogeology of the area and the screened intervals of adjacent groundwater monitoring wells. The system was installed by backfilling sand around the sampling ports and isolating the ports with bentonite seals. The method proved adequate. For future installations, however, development and evaluation of an alternative method is recommended. In the alternative method suggested, the multiport system would be placed inside a cased and screened well, using packers to isolate the sampling zones. (Author's abstract) In 1988, the Pacific Northwest Laboratory in-

COMBINING SURFACE GEOELECTRICS AND BOREHOLE MEASUREMENTS FOR CONTAMINATION CONTROL.

Nebraska Univ., Lincoln. Dept. of Civil Engineer-

ing. W. E. Kelly, I. Bogardi, W. Woldt, and A.

W. E. Acity, I. Bogardi, W. Wolti, and A. Bardossy. IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 143-152, 7 fig, 13 ref. USGS Grant No. 14-08-0001-G1133.

Descriptors: \*Borehole geophysics, \*Electrical well logging, \*Geophysical surveys, \*Geostatistics, \*Groundwater pollution, \*Groundwater quality, \*Kriging, \*Water pollution control, \*Water quality management, Geophysical methods, Groundwater management, Mapping, Monitoring, Network design, Plumes, Pollutant identification, Radioactive wastes, Rhode Island, Specific conductivity, Water resources management.

Remediation of polluted groundwater starts with an accurate evaluation of the degree and extent of

the contamination. This evaluation requires a monitoring network and the network commonly increases in sophistication as the study progresses from preliminary evaluation to design of the remefrom preliminary evaluation to design of the remedial action. Surface geoelectrics have been combined with borehole information to define a plume of contaminated groundwater. The methodology allows for the uncertainty of the monitoring network to be quantified and for the design of the most effective expansion of a network. The methodology was applied to a plume at a low-level radioactive site in Rhode Island. Variograms for reactive site in know stand. Variograms for specific conductance were obtained from the direct borehole data, and were used with kriging techniques to estimate the areal distribution of specific conductance characterizing the extent and intensity of pollution. An accuracy analysis revealed the irregular pattern of well locations manifested by the reduced error estimates near monitoring wells.

Mapping the interpreted electromagnetic data closely paralleled the direct data methodology. A variogram of the vertical dipole data was computed and used in the kriging process to map the electromagnetic data. Comparison shows a large degree of correlation between the location of high contamination levels. It is this correlation that can be employed to combine the two types of data (direct and geoelectric). The combination of data does reduce the estimation error and the reduction is measurable. (See also W91-02672) (Fish-PTT) W91-02685

ADAPTATION OF A LEAD-TESTING PRO-GRAM.

Hackensack Water Co., Harrington Park, NJ. D. Hoven, B. Dietel, and V. Leiby. Water Engineering and Management WENMD2, Vol. 137, No. 9, p 46-48, September 1990. 1 fig.

Descriptors: \*Drinking water, \*Lead, \*Pollutant identification, \*Schools, \*Testing procedures, New Jersey, Public relations, Regulations, Water analysis, Water sampling.

In 1989, the Hackensack Water Company (HWC), Harrington Park, NJ, developed a lead-testing program for area schools. The program includes a one and one-half hour slide show and seminar that covers the following: (1) pertinent federal legislation and regulations, such as the Lead Contamination Control Act, the Lead Ban, and the Lead and Contamination Control Act, the Lead Ban, and the Lead and Contamination Control Act, the Lead Ban, and the Lead and Contamination Control Act, the Lead Ban, and the Lead and Contamination Control Act, the Lead Ban, and the Lead and Contamination Control Act, the Lead Ban, and the Lead and Contamination Control Act, the Lead Ban, and the Lead and Contamination Control Act, the Lead Ban, and the Lead and Contamination Control Act, the Lead Ban, and the Lead and Contamination Control Act, the Lead Ban, and the Lead and Contamination Control Act, the Lead Ban, and the Lead and Contamination Control Act, the Lead Ban, and the Lead and Contamination Control Act, the Lead Ban, and the Lead Contamination Control Act, the Lead Ban, and the Lead Contamination Control Act, the Lead Ban, and the Lead Contamination Control Act, the Lead Ban, and the Lead Contamination Control Act, the Lead Ban, and the Lead Contamination Control Act, the Lead Ban, and the Lead Contamination Control Act, the Lead Ban, and the Lead Contamination Control Act, the Lead Ban, and the Lead Ban, and the Lead Contamination Control Act, the Lead Ban, and the Lead Contamination Control Act, the Lead Ban, and tion Control Act, the Lead Ban, and the Lead and Copper Rule; (2) the various sources of lead contamination, such as industries, lead-based paints and lead plumbing; (3) the sources of lead in drinking water, including source water contamination and contamination due to corrosion of fixtures, interior plumbing and service connections; (4) health effects of lead contamination, especially as it relates to children; (5) the HWC's sampling program; and (6) the types of remediation available to schools, such as removal of lead contaminated coolers, flushing, and replacing lead solder and pipes. Although the Environmental Protection Agency (EPA) guidance manual for lead in schools was used as the basis for the HWC program, a number of changes were made to decrease gram, a number of changes were made to decrease the burden on schools both from a cost and a manpower perspective. To avoid the necessity of developing a plumbing profile, which the EPA uses as a screening device to limit the number of samples collected and therefore the analysis costs, uses as a screening device to limit the number of samples collected and therefore the analysis costs, HWC decided to test all drinking water taps. No profiles are required unless a problem shows up. The HWC sampling program also maintains a consistent sampling protocol across all types of drinking water taps. The actual sampling scheme consists of two sampling rounds. The first step consists of first-draw samples collected from all sources of drinking water in the school, as well as from the service connection. Any sites yielding samples containing 20 parts per billion or more of lead are resampled in the second round. Round 2 sampling consists of a first draw for verification of the first-round sample result, a short flush of 30 seconds, and a longer flush of 3 minutes. Samples are then returned to the HWC laboratory where they are logged in and analyzed. In most cases, schools opt to flush the taps rather than investigate the causes. (Korn-PTT) W91-02765

APPLICATION OF DIRECT PLAQUE ASSAY FOR DETECTION AND ENUMERATION OF BACTERIOPHAGES OF BACTEROIDES FRA-GILIS FROM CONTAMINATED-WATER SAM-PLES.

PLES, Malaga Univ. (Spain). Dept. of Microbiology. R. Cornax, M. A. Morinigo, I. G. Paez, M. A. Munoz, and J. J. Borrego. Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 10, p 3170-3173, October 1990. 2 fig, 3 tab, 18 ref.

Descriptors: \*Bacteriophage, \*Bioassay, \*Laboratory methods, \*Monitoring, \*Pollutant identification, Bacteria, Bioindicators, Fecal coliforms, Microbiological studies, Population density.

Bacteriophages of Escherichia coli are considered reliable indicators of the fecal pollution of natural waters. The direct double-agar-layer plaque assay for the detection and enumeration of specific bac-teriophages of Bacteroides fragilis from contaminated-water samples was performed. Several fac-tors that affect the methods, such as conditions of nated-water samples was performed. Several lactors that affect the methods, such as conditions of the bacterial culture, composition of the sasay medium, addition of divalent cations, and decontamination techniques applied to the sample, were evaluated. The results obtained show that the direct assay technique is more efficient than the most-probable-number technique. The direct assay technique involves cells of the host bacteria being cultured with an atmosphere of 20% carbon dioxide and 80% nitrogen. Sample decontamination is performed by using membrane filtration (0.45 microm pore size) with membranes previously treated with 10 ml of 3% beef extract (pH 9.5). In the case of samples with a high degree of pollution, the medium should be supplemented with vancomycin and kanamycin. A higher recovery of bacteriophages was obtained from 17 of 24 samples with the direct assay. The two methods only showed similar results from samples with a low degree of pollution. (Brunone-PTT)

STABILITIES OF CARBOXYLIC ACIDS AND PHENOLS IN LOS ANGELES RAINWATERS DURING STORAGE.

California Univ., Los Angeles. Inst. of Geophysics and Planetary Physics.

M. K. Kawamura, and I. R. Kaplan. Water Research WATRAG, Vol. 24, No. 11, p 1419-1423, November 1990. 4 fig, 18 ref.

Descriptors: \*Carboxylic acids, \*Chemistry of pre-cipitation, \*Phenols, \*Pollutant identification, \*Precipitation, \*Sample preservation, \*Water anal-ysis, Acetic acid, Aromatic acids, Benzoic acid, Fatty acids, Formic acid, Hydrogen ion concentra-tion, Los Angeles, Microbial degradation, Volatile aliphatic acids.

Organic compounds in rainfall may originate from biogenic or anthropogenic sources, or from photochemical reactions in the atmosphere. Concentration changes of acidic organic compounds (volatile aliphatic acids, fatty acids, aromatic acids and phenols) in rainwaters collected in Los Angeles, CA, were studied during storage experiments (up to 45 days). Carboxylic acids decreased with time in the order: benzoic acid < fatty acids < volatile acids. Although the observed losses have not been shown to result from microbial degradation, such a process is highly likely. Degradation of these acids, especially formic and acetic acids which are major components may result in a pH increase, during storage of rain. By contrast, toluic acids and phenols did not show a decrease in concentration after 2 weeks of storage indicating that these toxic compounds are resistant to microbial degradation in urban rainwater. (Author's abstract) W91-02800

MECHANISM OF ENRICHMENT OF TRACE METALS ON FINE SLUDGES COLLECTED FROM FILTRATION PLANTS.

Kansei Kogyo K.K., Sakata (Japan). Inst. for Envi-ronmental Measurement.

H. Teraoka, and S. Nakashima. Environmental Geology and Water Sciences

#### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

#### **Group 5A—Identification Of Pollutants**

EGWSEI, Vol. 16, No. 2, p 143-148, 1990. 4 fig, 1

Descriptors: \*Analytical techniques, \*Sludge analysis, \*Suspended solids, \*Trace metals, \*Water treatment, Cadmium, Cobalt, Copper, Ion exchange, Iron, Japan, Leachates, Leaching, Lead, Manganese, Nickel, Organic matter, Oxides, River sediments, Silver, Sludge solids, Sulfides, Tin, Time

In the analysis of natural water, it is of interest to In the analysis of natural water, it is of interest to determine quantities of trace metals in potable water sludges, since these trace metals, derived from yearly averages of suspended solids from the river, not only influence the environment, but will also help in investigating the mechanism of trace metals on solids suspended in river water. Fine sludges were collected from five filtration plants in sludges were collected from five filtration plants in Japan, and the partitioning of ten metals (Ag, Cd, Mn, Zn, Pb, Cu, Sn, Co, Ni, and Fe) in them was determined by selective leaching techniques. It was found that the available amounts, which show the total of each metal leached between 1 M CH3COONH4 and 30% H2O2, for Ag, Cd, and Mn, ranged from 51% to 98% for five sludges. The available amounts for Zn, Pb, Cu, and Sn were 47% to 92% for five sludges. The most important fraction for Co, Ni, and Fe, except the sludge from the Inazawa filtration plant which is important raction for Co, N, and Fe, accept me sludge from the Inagawa filtration plant which is markedly polluted by organic matter, was the crystalline particle. Therefore, the above metals, except Co, Ni, and Fe, are thought to be enriched on ion-exchangeable sites, organic matter, hydrous Fe/Mn oxides, and sulfides in fine sludges. (Author's abstract) W91-02819

DETERMINATION OF PHOTOCHEMICALLY PRODUCED HYDROXYL RADICALS IN SEA-WATER AND FRESHWATER. Rosenstiel School of Marine and Atmospheric Sci-ence, Miami, FL. Div. of Marine and Atmospheric

Chemistry.

X. Zhou, and K. Mopper.

Marine Chemistry MRCHBD, Vol. 30, No. 1/3, p
71-88, 1990. 4 fig, 3 tab, 37 ref.

Descriptors: \*Chemical interactions, \*Fate of pol-lutants, \*Freshwater, \*Photochemistry, \*Pollutant identification, \*Seawater, Chemical analysis, Deg-radation, Laboratory methods.

A variety of short-lived, reactive chemical species (free radicals and excited state species) are known to be photochemically produced in natural waters. to be photochemically produced in natural waters. Some of these transients may strongly affect chemical and biological processes, and they have been implicated in the degradation of organic pollutants and natural organic compounds in aqueous environments. Previous studies demonstrated that the romments. Previous studies demonstrated that the highly reactive hydroxyl radical (OH) is photochemically formed in seawater. However, the quantitative importance of this key species in the sea has not been previously studied because of past analytical limitations. By using a highly sensitive probe based on alpha-hydrogen abstraction from methanol, production rates were measured of steady state concentrations of photochemically produced OH radicals in coastal and open ocean seawater and freshwaters. The validity of the method was tested by intercalibrating with an independent. and freshwaters. The validity of the method was tested by intercalibrating with an independent, OH-specific reaction, hydroxylation of benzoic acid, and also by competition kinetics experiments. OH production rates and steady state concentrations for freshwaters are in excellent agreement with those measured by previous investigators for similar waters. In contrast, for seawater, the values measured are 1-3 orders of magnitude higher than previously predicted by models, indicating that there is a major unknown photochemical OH source(s) in seawater. (Author's abstract)

HYDROCARBON POLLUTION IN PARTICLE-RICH WATERS (GULF OF FOS-SUR-MER): COMPARATIVE STUDY OF EXTRACTION PROCEDURES.

Centre d'Oceanologie de Marseille (France). R. Siron, and G. Giusti. Marine Chemistry MRCHBD, Vol. 30. No. istry MRCHBD, Vol. 30, No. 1/3, p

379-388, 1990. 1 fig, 2 tab, 30 ref. French Ministry of Science and Technology Grant No. DGRST 82-217.

Descriptors: \*Chromatography, \*Gulf of Fos-sur-mer, \*Hydrocarbons, \*Oil pollution, \*Pollutant identification, \*Water pollution sources, Alkanes, Chemical treatment, Coastal areas, Extraction, France, Lipids, Organic compounds, Particulate matter, Path of pollutants, Physical treatment.

The direct liquid-liquid extraction of hydrocarbons, without filtration of water supplies, can not be used for particle rich waters because of low yields and the selectivity towards particulate lipid classes. The ratios of hydrocarbons/total extractable matter and n-alkane/total hydrocarbons spollution indices-are altered in unfiltered water samples. The separation of dissolved and particulate phases and their specific extraction are indispensable for the complete recovery of the total hydrocarbons and alkanes from the water. Likewise, the n-alkane distribution and related Carbon Preference Index are influenced by the incomplete wise, the n-alkane distribution and related Carbon Preference Index are influenced by the incomplete extraction of high molecular weight compounds in unfiltered samples. Conversely, the n-C17/pristane (Pr), n-C18/phytane (Phy) and Pr/Phy ratios are not significantly affected by direct extraction. However, these indices sometimes are strongly influenced by biological contributions. The Pr Pry ratio generally seems to be convenient for Phy ratio generally seems to be convenient for characterization of the anthropogenic origin of hy-drocarbons. (Author's abstract)

COMPARATIVE SURVEY OF IMPOSEX IN NORTHEAST PACIFIC NEOGASTROPODS (PROSOBRANCHIA) RELATED TO TRIBUTYLITIN CONTAMINATION, AND CHOICE OF A SUITABLE BIOINDICATOR.
Victoria Univ. (British Columbia). Dept. of Biol-

ogy.
D. A. Bright, and D. V. Ellis.
Canadian Journal of Zoology CJZOAG, Vol. 68, No. 9, p 1915-1924, September 1990. 10 fig, 3 tab, 14 ref.

Descriptors: \*Bioindicators, \*Gastropods, \*Organotin compounds, \*Water pollution effects, Animal physiology, British Columbia, Comparison studies, Ecotoxicology, Field tests, Surveys.

Imposex, the manifestation of male morphological sex characteristics in females of functionally diocious neogastropod taxa, is an abnormal response to tri-n-butyltin (TBT) contamination introduced to the marine environment in antifouling paints. Since the phenomenon has been thoroughly described only in Atlantic species, a comparative survey of field populations from British Columbia was undertaken, and field studies were carried out to assess the relative value as bioindicators of species in the genus Nucella from the Pacific coast. The majority of neogastropods studied to date have demonstrable signs of imposex, although this leads to sterilization of females in only a few species, depending on differences in the development in females of a pallial vas deferens. Within the Nucella species complex, N. lamellosa, N. canaliculata, and N. emarginata show promise as TBT the Nucella species complex, N. lamellosa, N. canaliculata, and N. emarginata show promise as TBT bioindicators. Only the response of N. emarginata, however, was related to TBT bioaccumulation, based on measurements of a limited number of samples. This is attributed to the apparent irreversibility of imposex, the temporal variability of both environmental levels and tissue burdens of TBT, and considerably shorter life span of N. emarginata relative to that of N. lamellosa and N. canaliculata. The geographic distribution of imposex in Nucella spp. suggests that waterborne concentrations of TBT sufficiently high to induce imposex occur over large areas within British Columbia where exchange with oceanic water is limited. (Author's exchange with oceanic water is limited. (Author's abstract) W91-02894

COMPUTER-CONTROLLED AUTOMATED RAIN SAMPLER (CCARS) FOR RAINFALL MEASUREMENT AND SEQUENTIAL SAM-

Battelle Pacific Northwest Labs., Richland, WA.

For primary bibliographic entry see Field 7B. W91-02914

ASIATIC CLAM, CORBICULA SPP., AS A BIO-LOGICAL MONITOR IN FRESHWATER ENVI-RONMENTS.

Syracuse Research Corp., NY. Aquatic Toxicology Lab.
F. G. Doherty.

Environmental Monitoring and Assessment EMASDH, Vol. 15, No. 2, p 143-181, September 1990. 3 tab, 87 ref.

Descriptors: \*Aquatic habitats, \*Bioaccumulation, \*Bioindicators, \*Clams, \*Literature review, \*Mollusks, \*Organic pollutants, Drainage systems, Ecological distribution, Ecological effects, Population

Asiatic clams, Corbicula ssp., are filter-feeding freshwater bivalves that are widely distributed, abundant, and fast growing with a lifespan of 1-3 years. A review of the existing literature demonstrates that Asiatic clams can concentrate organic strates that Asiatic clams can concentrate organic pollutants from both water and sediment and heavy metals from water. In conjunction with these traits, they exhibit a high tolerance for the effects resulting from exposure to toxic substances. While an organism must possess these traits to serve as an effective biological monitor, they have also permitted the Asiatic clam to rapidly colonize natural and industrial environments resulting in purported ecological disturbances and severe economic repercussions, respectively. Its invasive biofouling attributes therefore restrict the use of this clam for biomonitoring purposes from Corbicula-free drainage systems. (Author's abstract) W91-02944

#### 5B. Sources Of Pollution

TOTAL HEAVY METAL CONCENTRATIONS CONTAINED ON THE SEDIMENT'S SURFACE

OF ALGIERS BAY.
Laboratoire de Chemie Marine, Algiers (Algeria).
A. Chouikhi, B. Sellali, and M. Azzouz.
Pelagos, Vol. 7, No. 1, p 5-7, 1989. 1 fig, 2 tab, 4

Descriptors: \*Algiers Bay, \*Heavy metals, \*Path of pollutants, \*Pollutant identification, \*Sediment contamination, Atomic absorption spectrophotometry, Cadmium, Copper, El-Harrach, Industrial wastes, Lead, Mercury, Water pollution sources,

Sediment samples from seven sites in Algiers Bay were analyzed for Zn, Cu, Hg, Cd and Pb. The samples were dissolved in Aqua Regia and analyzed by atomic absorption spectrophotometry. High concentrations of heavy metals were found near the mouth of the El-Harrach sampling region. These concentrations fall to a lower level at a distance of 1 km from the El-Harrach site. However, the concentrations of Ph and Hg increased from the concentration of the custance of 1 km from the El-Harrach site. However, the concentrations of Pb and Hg increased from the mouth of the El-Harrach up to the parts plant. These high levels were probably due to factories in and around Algiers and the operation of motors in the region. (King-PTT)
W91-02053

MACROBENTHIC POPULATION OF THE PORT OF ALGIERS (LES PEUPLEMENTS MACRO BENTHIQUES DU PORT D'ALGER), LaCroatoire de Chemie Marine, Algiers (Algeria). A. Bakalem, C. Rebzani, J. C. L. Roman, and M. Tahar.

Pelagos, Vol. 7, No. 1, p 35-40, 1989. 1 fig, 2 tab, 2 ref. English summary.

Descriptors: \*Benthic environment, \*Marine envi-Descriptors: "Benthic environment, "Marine envi-ronment, "Path of pollutants, "Port of Algiers, Benthic fauna, Benthic flors, Bottom samplins, Hydrogen ion concentration, Oxygen, Physical properties, Suspended solids, Water quality, Water temperature

The southern part of the Port of Algiers is more polluted than the northern part of the port accord-

#### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

#### Sources Of Pollution-Group 58

ing to results from 28 stations. Physical and chemical parameters such as dissolved oxygen, pH, temperature and suspended matter were measured, and the benthic populations were analyzed at the stations in order to determine the condition of the water at the sites. The benthic population indicated that the southern region port was more polluted than the northern region of the port. There was an azoic region in the south and a diversified population in the north. However the northern population is still subnormal. An intermediately polluted region exists in the between these two regions. (King-PTT) W91-02054

PROBLEMS OF GROUND WATER TREAT-MENT IN AN AREA OF DEPRESSION (ZUR PROBLEMATIK DER GRUNDWASSERAUF-BEREITUNG IN EINEM ABSENKUNGSGE-

rankenhaus Treuenbrietzin (German D.R.).

H. Thielemann.

Zeitschrift fuer Wasser - und Abwasser Forschung

ZWABAQ, Vol. 23, No. 3, p 116-118, June 1990. 1

tab. English summary.

Descriptors: \*Groundwater quality, \*Water treatment, \*Wells, Carbon dioxide, Filtration, Germany, Halle-Neustadt, Hydrogen ion concentration, Iron, Manganese, Water quality.

Experimental chemical, chemical-physical and biological tests were conducted to study the problem of the formation of chemical compounds containing Fe and Mn in wells connected with the treatment of groundwater in the settling area or depression of Halle-Neustadt. The effects of de-acidification, softening, removal of iron and manganese, and treatment with activated carbon were studied on a laboratory-scale and a semi-industrial scale. The pH of the raw water was 7.2 and the amount of free COZ was 75 mg/L. After aeration and filtering through a porous carbon filter bed for 20 minutes, the pH was 8.2 and the free COZ was 10 mg/L. The results show that at present the chemiminutes, the pH was 8.2 and the free CO2 was 0 mg/L. The results show that at present the chemical formation of Fe and Mn compounds has not yet started in the wells which were tested. The beginning of the formation of chemical compounds containing Fe and Mn is regarded as representative because samples were taken along the entire length of the well. Although positive redox potentials were determined, further conditions for acute premature ageing of the wells do no exist. (King-PTT) W91-02060

SOURCE, COMPOSITION AND FLUX OF PO-LYCYCLIC AROMATIC HYDROCARBONS IN SEDIMENTS OF THE RIVER DERWENT, DERBYSHIRE, U.K. Derbyshire Coll. of Higher Education, Derby (England). Div. of Biology. K. M. Evans, R. A. Gill, and P. W. J. Robotham. Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 1/2, p 1-12, May 1990. 3 fig, 1 tab, 41 ref.

Descriptors: \*Nonpoint pollution sources, \*Path of pollutants, \*Polycyclic aromatic hydrocarbons, \*Sediment analysis, \*Sediment contamination, \*Water pollution sources, England, Fluorescence, High performance liquid chromatography, Highways, Mass spectrometry, Rainfall-runoff relationships, Storm runoff, Storms.

Freshwater surface sediments from eleven sites on the river Derwent (Derbyshire, England) were sampled monthly during the period of June 1987 to May 1988. Samples were extracted and separated and the polycyclic aromatic hydrocarbon (PAH) extract was analyzed using high performance liquid chromatography with a fluorescence detector. Identity of the peaks was confirmed by coinjection and gas chromatography-mass spectrometry. Changes in total levels of nine parent PAH compounds were compared with rainfall data obtained for the study area. The time lag between PAH incorporation into sediments and preceding storm events varied between a minimum of 4 and a maximum of 30 days. All sites were affected by diffuse PAH pollution. At certain sites and at times of heavy rainfall this contamination is overlaid by a greater input of PAH to the sediment from point Freshwater surface sediments from eleven sites on

sources. Road runoff was identified as a major diffuse source underlying atmospheric and point sources at particular sites. Small industrial areas had a greater influence on sediment PAH than the larger commercial or residential areas. Pyrene and fluoranthene were the dominant parent com-pounds, explained by their availability and relative solubility. (Author's abstract) W91-02079

PAH AND ORGANIC CONTENT OF SEDI-PAH AND ORGANIC CONTENT OF SEDI-MENT PARTICLE SIZE FRACTIONS. Derbyshire Coll. of Higher Education, Derby (England). Div. of Biology. K. M. Evans, R. A. Gill, and P. W. J. Robotham. Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 1/2, p 13-21, May 1990. 5 fig. 2 tab, 40 ref.

Descriptors: \*Particle size, \*Path of pollutants, 
\*Polycyclic aromatic hydrocarbons, \*Sediment 
contamination, Adsorption, Organic matter, Re-

gression analysis.

The organic matter content of aquatic sediments has been shown to be very important in complexing hydrophobic toxic pollutants. The relationship of nine polycyclic aromatic hydrocarbons (PAH) with organic matter present in various Derwent River (Derby, England) sediment size fractions, from 63 microm to 1.0 to 2.0 mm, has been investing the sediment size fractions which may be explained by the presence of two types of organic matterial in the sediment. Maxima in both factors are found in the two largest and the smallest size fractions. A positive linear relationship between PAH concentration and organic matter has been demonstrated and the slope of this relationship has been used to identify sites where PAH pollution is generally high. The relative proportion of each PAH compound in the sediment remains relatively constant regardless of temporal and spatial differences in total PAH concentration and organic matter content and certain PAH compound organic matter content and certain PAH compound the sediment remains relatively constant regardless of temporal contents and organic matter content and certain PAH compound organic matter content and certain PAH compound the sediment was content and certain PAH compound the sediment content and certain PAH compound the sediment content and certain PAH compound the sediment content and certain PAH compound certa and spatial differences in total PAH concentration and organic matter content and certain PAH compounds may be grouped together depending on their association with organic matter. Differing PAH compound availabilities, competition for adsorption sites and the reactivity of PAH compounds may all result in the unchanging sediment PAH profile seen in each size fraction. The organic material present in the sediment may have a similar affinity for all PAH's in a particular group. (Author's abstract) thor's abstract)

LEAD, ZINC, CADMIUM, AND FLUORIDE IN SMALL MAMMALS FROM CONTAMINATED GRASSLAND ESTABLISHED ON FLUORO-SPAR TAILINGS. derland Polytechnic (England). School of Biol-

J. A. Cooke, S. M. Andrews, and M. S. Johnson. Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 1/2, p 43-54, May 1990. 6 tab, 29 ref.

Descriptors: \*Bioaccumulation, \*Heavy metals, \*Industrial wastes, \*Mine wastes, \*Path of pollutants, Cadmium, Fluorides, Lead, Metabolism, Waste disposal.

Waste materials produced by the fluorospar extraction industry contain high concentrations of a number of potentially toxic elements normally found only in trace amounts. These wastes are deposited in tailings lagoons or dams, which can be revegetated after dewatering. The total body concentrations of lead, cadmium, and fluoride were higher at such a site compared to an uncontaminated control site for three species of small mammals, Apodemus sylvaticus, Microtus agrestis, and Sorex araneus. Zinc was also higher in M. agrestis and S. araneus, but in A. sylvaticus it significantly decreased. There was evidence of homeostatic control of zinc in all three species even at the higher dietary intakes at the tailings dam. Accumulation in kidney, liver and bone (femur) showed the expected pattern with lead and fluoride highest in bone and cadmium in the kidney for both the control and the contaminated sites. The only exception was S. araneus at the contaminated site where cadmium was highest in the liver, not the

kidney. The accumulation of lead, cadmium, and fluoride at the contaminated site was in the decreasing species order S. araneus > M. agrestis > A. sylvaticus in terms of total body concentrations or target organ concentration. This order probably reflects the decreasing dietary intake rates of the three species although physiological interspecific differences may be of significance. For example, S. araneus showed considerable capability to bioconcentrate cadmium to much higher body concentrations than present at the contaminated site. The lack of any consistent pattern of correlation for the tissue concentrations of lead, zinc, cadmium and fluoride is unexpected, but the small sample size may have prevented any significant correlations from being made. (Author's abstract)

TRACE ELEMENT ACCUMULATION IN THE TISSUE OF FISH FROM LAKES WITH DIFFERENT PH VALUES.

Department of Energy, New York. Environmental Measurements Lab.

Reassurements Lao.

R. A. Stripp, M. Heit, D. C. Bogen, J. Bidanset, and L. Trombetta.

Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 1/2, p 75-87, May 1990. 7 tab, 37 ref.

Descriptors: \*Acid lakes, \*Acid rain effects, \*Bioaccumulation, \*Fish physiology, \*Hydrogen ion concentration, \*Path of pollutants, \*Trace elements, Aluminum, Selenium, Spectrophotometry, Tissue analysis, Water chemistry.

Two species of fish, omnivorous Catostomus commersoni (white suckers) and carnivorous Perca flavescens (yellow perch) were collected from natural lakes with different pH ranges (circumneutral, pH 6.5 to 6.8; variable, pH 5.8 to 6.7; and acidic, pH 4.9 to 5.4). The lakes are located in the North Branch of the Big Moose River drainage system in the New York State Adirondack Park Preserve. Concentrations of potentially toxic elements (aluminum, cadmium, copper, lead, and selenium) were measured by electrothermal atomic absorption spectrophotometry in water, sediment, and fish (bone, gill, kidney, liver, and muscle) from each lake. The results showed that concentrations of lead and cadmium were significantly higher (P each lake. The results showed that concentrations of lead and cadmium were significantly higher (P < 0.05) in some of the tissues of the fish collected from the acidic lake. Also, the yellow perch from the acidic lake had significantly higher (P < 0.05) selenium concentrations in their muscles and livers than fish from the other lakes. The concentrations than has from the other lakes. The concentrations of aluminum were elevated in the gill tissues of both fish species from the acidic lake relative to fish from the other lakes. (Author's abstract) WOL MONE

SPECIATION AND BEHAVIOR OF ARSENIC IN THE NILE DELTA LAKES.

A R. Abdel-Moati. Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 1/2, p 117-132, May 1990. 4 fig. 3 tab, 31 ref.

Descriptors: \*Arsenic, \*Nile Delta, \*Nonpoint pol-lution sources, \*Path of pollutants, \*Water pollu-tion sources, Agricultural runoff, Coastal waters, Detergents, Fertilizers, Flushing, Herbicides, Med-iterranean Sea, Phosphates, Retention time, Specia-tion, Wastewater pollution.

Dissolved and particulate arsenic species were measured in three Nile River coastal lakes in Egypt. Apart from input sources, arsenic levels lie within the range 1.2 to 18.2 microg/L (dissolved) and between 1.2 and 8.7 microg/g (particulate). Arsenic (V) is the predominant dissolved arsenic species constituting between 85% and 95% of total dissolved arsenic (TDA). Opposite to local sewage discharge points, arsenic (III) appeared, constituting between 14% and 33% of TDA at low and high water discharge periods, respectively. Dimethylarsenic is the dominant organic arsenic form, reaching 22% of TDA while the maximum concentration of monomethylarsenic (1.0 microg/L) constituted about 8% of TDA. Particulate arsenic is mostly partitioned among reducible and senic is mostly partitioned among reducible and detrital phases while the organic phase appeared

#### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 5B-Sources Of Pollution

dominant in eutrophic areas (> 30% of particulate arsenic). About 413 tons/year arsenic entered the northern delta lakes via agricultural drains and wastewater discharge. Phosphate fertilizers, detergents, herbicides, and loamy Nile deposits are the main arsenic sources to the drainage system. Fifty-two percent of the total arsenic deposited in the Nile delta lakes is transported to the Mediterranean coastal seawater through the lakes outlets. This amount is potentially hazardous to the coastal environment. (Author's abstract)

TRACE METAL ANALYSIS OF SEWAGE SLUDGE AND SOILS IN BAHRAIN. Bahrain Univ., Manama. Dept. of Chemistry. For primary bibliographic entry see Field 5E.

EFFECT OF SOLID-PHASE SPECIATION ON METAL MOBILITY AND PHYTOAVAILABI-LITY IN SLUDGE-AMENDED SOIL. Instytut Uprawy, Nawozenia i Gleboznawstwa, Pulawy (Poland). Trace Element Lab. For primary bibliographic entry see Field 5E. W91-02089

SOLUTE TRANSPORT THROUGH SATURATED SOILS: A STUDY OF THE PHYSICAL NON-EQUILIBRIUM MODEL.
Claremont Graduate School, CA. Dept. of Mathe-

G. Mahinthakumar, and S. Vigneswaran. Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 1/2, p 161-180, May 1990. 10 fig, 3 tab, 17 ref,

Descriptors: \*Fate of pollutants, \*Groundwater pollution, \*Model studies, \*Path of pollutants, \*Saturated soils, \*Soil contamination, \*Solute transport, Adsorption, Equilibrium, Mass transfer, Soil physical properties, Solutes.

A two-region physical non-equilibrium transport model incorporating mobile and immobile regions (Van Genuchten and Wieringa model) was used to predict the movement of solutes through saturated predict the movement of solutes through saturated soils. Freundlich's nonlinear isotherms were coupled with this transport model to account for the adsorption phenomena. A CSMP III (Continuous System Modeling Program) program was used to solve this problem numerically. The model was tested for 3 sets of experimental data having different soil and solute properties. The experimental curves were fitted by adjusting the 3 parameters, mass transfer coefficients, distribution factor for sorption sites in the mobile region, and the fraction of mobile water content. The model predicted well only for fairly conservative solutes. To predict the movement of highly reactive solutes, such as cadmium, the model needs further modification. Effects of dispersion coefficient, mass transfer coefficients, distribution factor for sorption sites in the mobile region, and the fraction of mobile water content on the breakthrough curves were studied for highly reactive solutes (a term used for solutes with high adsorption coefficient and high mass transfer coefficient), although these effects were eignificant for mild solutes. Solute concentration profiles for a semi-infinite column (as in the field soils. Freundlich's nonlinear isotherms were couprofiles for a semi-infinite column (as in the field tuation) were predicted for 3 different case squanon) were predicted for 3 different cases and the penetration depths were compared with those obtained from Green and Ampt profiles. A Green and Ampt profile was a good approximation for finding the penetration depths in environmental impact assessment studies for mildly reactive so-lutes exhibiting fairly sharp solute fronts. (Author's abstract) abstract) W91-02090

UPTAKE OF CADMIUM AND NICKEL IN BANANA PRAWN (PENAEUS MERGUIENSIS DE MAND.

Balai Penelitian Veteriner, Bogor (Indonesia). Toxicology Section.

D. Darm Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 3, p 320-328, September 1990. 9 fig, 16 ref.

Descriptors: \*Bioaccumulation, \*Bioindicators, \*Cadmium, \*Marine animals, \*Nickel, \*Path of pollutants, \*Shrimp, \*Water pollution effects, Animal tissues, Dose-response relationships, Experimental data, Heavy metals.

The patterns of nickel and cadmium accumulation The patterns of nickel and cadmium accumulation were measured in juvenile bannan prawns (Penaeus merguiensis de Man). Prawns were exposed to the test metals (0-0.5 mg/L Cd or 0-2.0 mg/L Ni) for up to 30 d with replacement of the metal solutions every 3 d. At all experimental levels of exposure, Cd was most concentrated by the hepatopancreas and least concentrated by muscle over the 30 d period. Ni was accumulated to the greatest extent by the hepatopancreas followed by the gills and then the muscle. For both Cd and Ni, the rates of untake were linearly related to the metal concentrated purpose the metal concentrated when the metal concentrated were linearly related to the metal concentrated when the metal concentrated were linearly related to the metal concentrated were linearly related to the metal concentrated were linearly related to the metal concentrated when the metal concentrated were linearly related to the metal concentrated when the concentrated were linearly related to the metal concentrated when the metal concentrated were linearly related to the metal concentrated when the metal concentrated were linearly related to the metal concentrated when the metal concentrated were linearly related to the metal concentrated when the metal concentrated were linearly related to the metal concentrated when the metal concentrated were related when the metal concentrated then the muscle. For both Cd and Ni, the rates of uptake were linearly related to the metal concentration in the seawater over the concentration ranges studied. For Ni in all tissues, the relationship approximated one of direct proportionality, implying little metabolic control over uptake at the levels tested. A similar trend was observed for Cd in muscle tissue. The accumulation of Cd in all tissues was greater than for Ni, despite lower Cd test concentrations used. This suggests that the cell membranes are more permeable to Cd than to Ni which may account for the greater toxicity of Cd to these organisms. The limited ability of prawns to control uptake of either metal against changes in external concentrations suggests that they may have potential as bioindicators of pollution by Ni and Cd. (MacKeen-PTT) W91-02093

BARIUM BIOACCUMULATION IN CLAMS COLLECTED FROM DIFFERENT SALINITY REGIMES ALONG THE SAUDI COAST OF THE ARABIAN GULF.

University of Petroleum and Minerals, Dhahran (Saudi Arabia). Water Resources and Environment Div.

M. Sadiq, T. H. Zaidi, and H. Al-Mohana. Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 3, p 329-335, September 1990. 1 fig. 2 tab, 7 ref.

Descriptors: \*Barium, \*Bioaccumulation, \*Mol-lusks, \*Path of pollutants, \*Persian Gulf, \*Salinity, \*Saudi Arabia, Clams, Marine pollution, Oil industry. Sediment contamin

Barium bioaccumulation by clams (Maritrix maritrix) as a function of sediment concentration and seawater salinity was investigated along the Saudi coast of the Arabian Gulf. Samples of clams, seawater and sediment were obtained quarterly from each of 12 stations between March 1985 and April 1986. The maximum concentrations of Ba were found in sediments from Stations 8 and 12, both of which were probably affected by the drilling muds during the development of Beri and Manifa oil fields, respectively. The maximum Ba concentrations in clams were found in those from Station 12. No significant correlation between Ba concentrations in sediments and mean clam concentrations in sediments and mean clam concentrations tions in sediments and mean clam concentrations were found when all the data were considered. Removing the data for Stations 1 and 12 resulted in a significant linear correlation. No effect of salinity on Ba bioaccumulation by clams was found. (MacKeen-PTT) W91-02094

FATE OF PARATHION IN GROUND WATER IN COMMERCIAL CRANBERRY CULTURE IN THE NEW JERSEY PINELANDS.

Cook Coll., New Brunswick, NJ. Dept. of Environmental Science. ronmental Science. G. Winnett, P. Marucci, S. Reduker, and C. G.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 3, p 382-388, September 1990. 2 fig, 2 tab, 14 ref.

Descriptors: \*Agricultural chemicals, \*Agriculture, \*Cranberries, \*Groundwater pollution, \*New Jersey, \*Parathion, \*Path of pollutants, \*Pesticides, Aquifer testing, Bogs, Cohansey aquifer, Risk assessment, Soil contamination, Surface

The possible contamination of groundwater resulting from the recent use of parathion (O,O-diethyl O-4 nitrophenyl phosphorothioate) and its horizonal and vertical movement in the bog soil of the Cohansey aquifer, New Jersey, were examined. Parathion was applied by spray boom at 1 pound per acre three times per growing season. Surface waters and groundwaters were sampled weekly or his parathion, treated waters and groundwaters were sampled weekly or biweekly for one year for the parathion-treated bog and a control bog. In general, parathion, which was the New Jersey Agricultural Station's recommendation to the cranberry growers of New Jersey, showed no discernible vertical movement in the experimental bog from the surface water to the groundwater. There appears to be no correlation between the residues found in the surface water and soil with those few found in the groundwater. Where residues of parathion are found in the soil, concentrations are highest in the upper stratum. It thus appears that there is little danger of parathion pollution from applications made in normal cranberry culture at these sites. (MacKeen-PTT) PTT W91-02098

RESIDUES OF DDT AND HCH IN MAJOR SOURCES OF DRINKING WATER IN BHOPAL, INDIA.

Industrial Toxicology Research Centre, Lucknow (India). Pesticide Toxicology Lab.
T. S. S. Dikshith, R. B. Raizada, S. N. Kumar, M. K. Srivastava, and S. K. Kulshrestha.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 3, p 389-393, September 1990. 1 tab, 15 ref.

Descriptors: \*Chlorinated aromatic compounds, \*Chlorinated hydrocarbons, \*DDT, \*Drinking water, \*Groundwater pollution, \*India, \*Insecticies, \*Path of pollutants, Benzene hexachloride, Bhopal, Gas liquid chromatography, Halogenated pesticides, Metabolites, Pesticide residues, Water pollution, Water quality monitoring.

pollution, Water quality monitoring.

The presence of residual organochlorine insecticides (OCIs) such as HCH and DDT was studied in different sources of drinking water in and around Bhopal, India. A total of sixty samples from different wells, handpumps and ponds were analyzed for OCIs by gas-liquid chromatography and thin layer chromatography. HCH and DDT were detected in all samples tested. Water samples from wells had mean residual contents of 4.7 ppm HCH and 5.8 ppm DDT. Samples obtained from handpumps had on average 6.1 ppm residual HCH and i4.5 ppm residual DDT. Mean residual HCH and DDT contents of 9.9 ppm and 16.1 ppm were detected in pond water samples. The alpha isomer of HCH was most prevalent in all three water sources (52-53%), followed by beta (33-37%) and gamma (10-14%). pp'-DDD were also found in almost all the water samples, possibly indicating metabolic conversion and dehydrochlorination. Due to the carcinogenic and esterogenic potential of OCIs and their metabolites, regular monitoring of the drinking water on a national basis is recommended. (MacKeen-PTT) W91-02099

RESIDUES OF ORGANOCHLORINE INSECTI-

RESIDUES OF ORGANOCHLORINE INSECTI-CIDES IN FISH FROM MAHALA WATER RES-ERVOIR, JAIPUR, INDIA.
Rajasthan Univ., Jaipur (India). Dept. of Zoology.
P. Bakre, V. Misra, and P. Bhatnagar.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 3, p 394-398, September 1990. 1 tab, 15 ref.

Descriptors: \*Chlorinated hydrocarbons, \*Fish, \*India, \*Insecticides, \*Path of pollutants, \*Pesticide residues, Aldrin, Benzene hexachloride, DDT, Fish diets, Halogenated pesticides, Jaipur, Mahala Reservoir, Metabolites.

The levels of organochlorine insecticide (OC) residues were measured in different fish species from the Mahala Reservoir, a freshwater lake situated 40 km from Jaipur, India. Pesticides used in the catchment area (220 sq miles) are carried in agricultural

#### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

Sources Of Pollution-Group 5B

runoff from land to water where they are adsorbed on bottom sediments and may move to other components of the aquatic system. Sixty-four fish of four species were collected between November 1986 and September 1987 (12 Puntius sarana, 24 Channa punctatus, 12 Wallago attu, and 16 Labo bata) and tested for residues of alpha, beta, and gamma-HCH, aldrin, p.p'-DDT, DDE, and DDD. pata) and tested for residues of appha, peta, and gamma-HCH, aldrin, p.p'-DDT, DDE, and DDD. The highest OC residue quantities were detected in L. bata, a bottom feeder, the lowest in C. punctatus, which has a diversified diet with a large plankton share. A comparison of OC residue levels in various tissues indicated that the lowest levels were found in muscle, probably due to the low fat content and lack of active metabolic role for OC in muscle issue. (MacKeen-PTT)

TOXICITY EVALUATION OF THE PRO-POSED SECONDARY AND THE PRIMARY EFFLUENTS DISCHARGED TO MASSACHU-SETTS BAY

SETIS BAY. Springborn Labs., Inc., Wareham, MA. K. M. Jop, J. W. Williams, and R. B. Foster. Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 3, p 399-407, September 1990. 4 tab, 1 fig, 15 ref.

Descriptors: \*Bioindicators, \*Effluents, \*Massa-chusetts Bay, \*Municipal wastewater, \*Path of pollutants, \*Toxicity, \*Toxicology, \*Wastewater disposal, \*Wastewater treatment, \*Water quality standards, Chlorination, Deer Island, Marine pollu-tion, Nut Island, Primary wastewater treatment, Secondary wastewater, Water pollution sources, Water quality monitoring.

Primary effluents from the Deer Island and Nut Island wastewater treatment plants discharged to Massachusetts Bay and proposed secondary ef-fluents were tested for toxicity. The average concentrations of dissolved oxygen in unchlorinated and chlorinated samples were 2.8 and 6.5 mg/L, respectively. Total residual chlorine (TRC) conrespectively. Total residual chlorine (RC) con-centrations in secondary effluents were similar for both samples and ranged between 1.0 and 1.12 mg/ L. The results of the 7 day toxicity renewal test indicated that the survival of sheepshead minnows in unchlorinated effluent samples collected from both plants was significantly reduced compared with survival in chlorinated effluents. The results of the 96 h static acute toxicity tests indicated that survival of mysids in the chlorinated effluents was survival of mysids in the chlorinated effluents was reduced when compared with survival in unchlor-inated effluents; however, mysid response to chlo-rine was not substantial. Sea urchin sperm cell toxicity tests showed that toxicity of each effluent varied throughout the program. Generally, the chlorinated primary effluents were more toxic than the unchlorinated, and Nut Island effluents decreased sperm viability more than Deer Island effluents. The unchlorinated and chlorinated seccreased sperm viability more than Deer Island effluents. The unchlorinated and chlorinated secondary effluents were minimally toxic to sea urchin. Overall, the results of the study indicated that the wastewaters currently discharged to Boston Harbor are toxic, however the source of the toxicity is unknown. The chlorination treatment currently used at both treatment facilities increases the TRC concentration in the primary effluents and exaggerates the toxicity of the wastewaters. Biological monitoring conducted in the future on effluent discharged from the new secondary treatment plant should include assessment of the short-term and long-term biological effects of the discharged wastewaters. For short-term biomonitoring, the sea urchin fertilization test is recommended because it includes the evaluation of reproduction potential, is conducted in minutes, and is sensitive and simple to conduct. (MacKeen-PTI) PTT) W91-02101

ATTACHED AND FREE-LIVING DIVIDING BACTERIA IN TWO AQUATIC SYSTEMS. Universidad del País Vasco, Bilbao (Spain). Dept. de Microbiologia e Immunologia. For primary bibliographic entry see Field 2H. W91-02121

INFLUENCE OF PHYSIOLOGICAL CONDITION ON CADMIUM TRANSPORT FROM

HAEMOLYMPH TO HEPATOPANCREAS IN CARCINUS MAENAS.
Odense Univ. (Denmark). Biological Inst.

Odense Univ. - Chambard - Chambar

Descriptors: \*Bioaccumulation, \*Cadmium, \*Crabs, \*Dose-response relationships, \*Marine animals, \*Path of pollutants, Absorption, Crustacea, Heavy metals, Hemolymph, Hepatopancreas, Ion transport, Proteins.

Accumulation and binding of cadmium in the tissues of the shore crab Carcinus maenas (L.) were investigated in a series of laboratory experiments. investigated in a series of laboratory experiments. Cadmium was removed from the hemolymph with a half-life of approximately 10 h, and half of the cadmium removed from the hemolymph was taken up in the hepatopancreas. The efficiency with which individual crabs transported cadmium from the hemolymph to the hepatopancreas was strongly related to physiological parameters, such as concentrations of calcium and magnesium in the hepatopancreas, hemolymph volume and hemolymph protein concentration. The transport of cadmium from the hemolymph to the hepatopancreas was saturated in crabs exposed to more than 2-4 mg/L of cadmium in the seawater. In the hepatopancreas of unexposed crabs, cadmium was bound mg/L of cadmium in the seawater. In the hepato-pancreas of unexposed crabs, cadmium was bound mainly in the insoluble tissue fraction (40%) and in the protein fraction with a molecular weight of approximately 6,000 D (50%). Exposure to 0.25-1.5 mg/L cadmium for 2 w led to dose-dependent increases in the amounts of cadmium bound in the high-molecular weight protein fraction and in the insoluble tissue fraction. Cadmium may be trans-cotted from hemolymph either as frea ions (activeinsolution tissue fraction. Cadmium may be trans-ported from hemolymph either as free ions (active-ly or passively), transported with hemocyanin in a pinocytotic process or transported with amoebo-cytes. (Author's abstract) W91-02124

APPLICATION OF TWO-SITE/TWO-REGION MODELS FOR STUDYING SIMULTANEOUS NONEQUILIBRIUM TRANSPORT AND DEG-RADATION OF PESTICIDES.

Florida Univ., Gainesville. Dept. of Soil Science. A. P. Gamerdinger, R. J. Wagenet, and M. T. van Genuchten.

Soil Science Society of America Journal SSSJD4, Vol. 54, No. 4, p 957-963, July/August 1990. 5 fig,

Descriptors: \*Degradation, \*Fate of pollutants, \*Mathematical models, \*Path of pollutants, \*Pesticides, \*Sorption, Atrazine, Computer programs, Equilibrium, Isotherms, Organic compounds, Pore water, Soil columns, Soil contamination, Solute

Quantitative laboratory study of pesticide sorption Quantitative laboratory study of pesticide sorption and degradation during transport can provide insight into the basic processes affecting pesticide fate in field soils. Accordingly, the application of analytical solutions of two-site/two-region transport models useful in studying simultaneous pesticide sorption and degradation, were demonstrated. Soil column displacement experiments involving tritiated water, Cl and atrazine (2-chloro-4-ethylamino-fisiogropulamino-striazine) were conducted. tritiated water, Ci and atrazine (2-cnioro-4-etnylia-nino-6-isopropylamino-s-triazine) were conducted during steady-state water flow at two pore water velocities and two pesticide concentrations. The soil used was a Valois silly loam (coarse-loamy, mixed, mesic Typic Dystrichrept). Effluent data from these experiments were used to demonstrate the application of these analytical solutions, as well as a parameter estimation computer program based on these solutions. The ability to use laboratoryon these solutions. The ability to use laboratory-derived estimates of equilibrium sorption parameters to describe sorption under flowing conditions was evaluated at each flow velocity. Significant correlation between soil sorption partitioning and degradation prevents the simultaneous determination of both processes using these solutions. However, estimates of degradation obtained from mass balances of the column data were useful in identifying the equilibrium sorption parameters. Data collected elsewhere for 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) herbicide transport were used as an additional example of the application of the model with degradation. These techniques are ap-

plicable to other organic chemical contaminants. (Author's abstract) W91-02132

ORGANIC SELENIUM DISTRIBUTION IN SE-LECTED CALIFORNIA SOILS.

Oregon Graduate Inst. of Science and Technology, Beaverton. Dept. of Environmental Science and Engineering.

M. M. Abrams, R. G. Burau, and R. J. Zasoski Soil Science Society of America Journal SSSJD4, Vol. 54, No. 4, p 979-982, July/August 1990. 3 fig, 2 tab, 21 ref.

Descriptors: \*Agricultural runoff, \*California, Descriptors: "Agricultural runoft, "California, Kesterson Reservoir, "Organic compounds, "Path of pollutants, "Selenium, "Soil chemistry, "Subsur-face drainage, "Water pollution sources, Fulvic acids, Gas chromatography, Hunic acids, Mass spectrometry, Organic matter, Soil types, Topog-

The distribution of organic Se was determined in seven soils from central California. Six of these soils (one Typic Pelloxerert, three Typic Torriorthents, one Vertic Torriorthent, and one Entic sons (one lypic removers, three lypic for-riorthents, one Vertic Torriorthent, and one Entic Chromoxerert) were in a toposequence from an area thought to be relatively high (>1000 microg total Se/kg) in native Se, because of the high Se levels in the subsurface agricultural drainage water pumped into the Kesterson Reservoir (California). The seventh soil. Vols (a. France Vol. (California). pumped into the Kesterson Reservoir (California). The seventh soil, Yolo (a Typic Xerorthent), thought to be low in native Se, was included for comparison. Three of the soils in the toposequence had total Se levels less than 1000 microg kg; the basin soil (Tachi; Typic Pelloxerert) had less than the Yolo soil. A solution of 0.1 M NaOH/0.1 M alkaline pyrophosphate extracted an average of 12% of the total Se, ranging from 5 to 32%. Organic Se accounted for 50% or more of the NaOH/alkaline pyrophosphate extractable Se in all but the poorly drained Ciervo clay (Typic Toriorthent), which had about 40% in an organic form. Extracted organic Se compounds were fractionated into humates and hydrophobic fulvates. Selenium associated with hydrophobic fulvates was high in the soils of intermediate toposequence elevation. Selenomethionine was identified by gas chromatography/mass spectrometry in the hydroelevation. Selenomethionine was identified by gas chromatography/mass spectrometry in the hydro-philic fulvate fraction of the Yolo soil and in three soils from the toposequence. The high percentage of extractable Se associated with organic matter in these soils represents a pool of Se potentially avail-able to plants. (Author's abstract) W91-02134

TRITIUM, OXYGEN-18, AND DEUTERIUM DIFFUSION AT THE CONFEDERATION ROAD LANDFILL SITE, SARNIA, ONTARIO, CANADA.

University of Western Ontario, London. Faculty

of Engineering Science.

E. K. Yanful, and R. M. QR. M. Quigley.

Canadian Geotechnical Journal CGJOAH, Vol.

27, No. 3, p 271-275, June 1990. 4 fig. 1 tab, 19 ref.

Descriptors: \*Deuterium, \*Diffusion, \*Landfills, Descriptors: "Deuterium, "Dirtusion, "Landinis, \*Leachates, \*Ontario, "Oxygen isotopes, \*Path of pollutants, \*Tracers, \*Tritium, Biodegradation, Chemical interactions, Chemical reactions, Chlorides, Clay liners, Clays, Diffusion coefficient, Ficks Law, Infiltration, Isotopes, Sodium.

The Confederation Road Landfill is a closed municipal landfill situated about 6.4 km east-southeast of Sarnia, Ontario. The isotopes tritium, oxygen-18, and deuterium, which appear to have been concentrated in the leachate at the site, are shown to have migrated into the underlying natural claybarrier by molecular diffusion. The theoretical best-fits to the observed concentration profiles, using the error function solution to the transient diffusion equation (analogous to Fick's second law), give diffusion coefficients (in square centime-ters per second) of 0.000013 for both oxygen-18 and deuterium, and 0.000085 for tritium. Field concentration profiles for Cl(-) and Na(+) yielded The Confederation Road Landfill is a closed muconcentration profiles for Cl(-) and Na(+) yielded diffusion coefficients of 0.0000064 for chloride and 0.0000033 for sodium (also square cm/s). Tritium and chloride appear to have migrated a similar

#### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

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distance of approximately 2.0 m from the claywaste interface, compared with only 1.2 m for sodium, which has probably been retarded by adsorption onto clay exchange sites. Oxygen-18 and deuterium appear to have migrated the furthest at approximately 2.3 m. The tritium profile indicates that post-1953 rainwater entered the landfill site, probably mostly in 1967 when the landfill trench was excavated. High delta 018 and delta deuterium values, especially near the clay-waste interface, suggest mixing of 1967 rainwater with an isotopically enriched water, probably produced in the landfill either directly from enriched organic wastes such as leaves or by biodegradation processes. (Author's abstract)

HYDROGEOCHEMICAL PROCESSES CONTROLLING THE TRANSPORT OF DISSOLVED ORGANIC CARBON THROUGH A FORESTED HILLSLOPE.
Oak Ridge National Lab., TN. Environmental Sci-

ences Div.
P. M. Jardine, G. V. Wilson, J. F. McCarthy, R. J.
Luxmoore, and D. L. Taylor.
Journal of Contaminant Hydrology JCOHE6, Vol.
6, No. 1, p 3-19, July 1990. 11 fig, 37 ref.

Descriptors: \*Dissolved organic carbon, \*Forest watersheds, \*Organic carbon, \*Path of pollutants, \*Radioactive waste disposal, \*Solute transport, \*Storm runoff, \*Waste disposal, Carbon cycle, Hydrographs, Pollutants, Precipitation, Rainfall, Rainstorms, Soil chemistry, Soil horizons, Soil profiles, Soil water, Tennessee, Underground waste disposal, Water pollution sources.

The subsurface transport of dissolved organic carbon (DOC) through a proposed waste burial site during rain events was investigated in order to assess the role of colloid-mediated contaminant mobility. A sub-watershed (0.45 ha) located on a forested hillslope in eastern Tennessee was instrumented with an isolated soil pedon for one-dimensional transport studies, and a subsurface weir monitoring system for three-dimensional transport studies. The source of DOC in the soils resulted from dissolution of organic matter in the surface horizon during and between rain events, as well as from dissolution of organic matter in the surface horizon during and between rain events, as well as from a highly reactive B horizon which stored significant quantities of DOC in small pores. During large storms, the concentration of DOC was similar on ascending and descending limbs of the subsurface hydrograph, with a maximum concentration occurring at peak flow. During small storms chemical interactions with soil solution. storms chemical interactions with soil solution SO4(-) caused DOC concentrations to be greater on the ascending limb of the hydrograph, with maximum DOC concentrations occurring before peak flow. Because subsurface lateral flow through preferential paths predominated in the Bt2 and Bt3 horizons of the soil during storm events, the total cumulative flux of DOC downslope was generally much greater through the lower soil horizons. A significant component of mobile DOC consisted of significant component of mobile DOC consistent or hydrophobic organic solutes, even though this ma-terial was selectively adsorbed with soil depth relative to hydrophilic organic solutes. The signifi-cant mobility of hydrophilic DOC may enhance the environmental transport of contaminants. (Author's abstract) W91-02159

PERSISTENCE OF ALDICARB RESIDUES IN PERSISTENCE OF ALDICARB RESIDUES IN THE SANDSTONE AQUIFER OF PRINCE EDWARD ISLAND, CANADA.

Canada Centre for Mineral and Energy Technology, Elliot Lake (Ontario). Elliot Lake Lab.

R. E. Jackson, J. P. Mutch, and M. W. Priddle.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 1, p 21-35, July 1990. 10 fig, 1 tab, 16 ref.

Descriptors: \*Agricultural chemicals, \*Aldicarb, \*Carbamate pesticides, \*Groundwater, \*Groundwater pollution, \*Path of pollutants, \*Pesticide residues, \*Pesticides, \*Prince Edward Island, Aquifer characteristics, Glacial sediments, Groundwater movement, Groundwater quality, Half-life, Hydrogen ion concentration, Sandstones, Sorption.

Aldicarb residues were found in the shallow groundwaters of the fractured sandstone aquifer of

Prince Edward Island more than two years after the last application of the pesticide. Concentrations of aldicarb measured were relatively constant with time. It is deduced that the detoxifying abiotic sformation (hydrolysis) of aldicarb is inhibited transformation (hydrolysis) of aldicarb is inhibited by the low pH and temperature of the soil and groundwater, the former being partly due to the pH-buffering effects of ammonium fertilizer oxidation. Aldicarb residues remain constant and relatively high because their storage within the sand-stone matrix and subsequent diffusion back into the fractures of this dual porosity system. Attempts to simulate the observed persistence of aldicarb in this hydrogeologic environment using a one-dimensional solute transport simulation code were unhydrogeologic environment using a one-dimensional, solute transport simulation code were unsuccessful, probably because of the three-dimensional nature of the matrix diffusion process. The simulation suggested that the overall half-life for aldicarb in the till-sandstone system approaches 150 days. These results indicate that aldicarb is not readily degraded in the hydrologic system, and that some insitu storage mechanism is retaining undegraded aldicarb species and slowly releasing them over time. Mechanisms possibly playing a role include sorption of aldicarb and its slow release, downslope migration of aldicarb within the lease, downslope migration of aldicarb within the flow system, inhibition of degradation, slow infil-tration through the unsaturated till overlying the sandstone, and matrix diffusion within the sand-stone and slow release. (Tappert-PTT)

MODELING THE MASS-TRANSFER RATE OF RADIOACTIVE COBALT FROM A SYNTHETIC GROUNDWATER TO VOLCANIC TUFF

Howard Univ., Washington, DC. Dept. of Chemical Engineering.

M. G. Rao, H. R. Fuentes, W. L. Polzer, and E. H.

M. O. Rao, H. R. Fuentes, W. L. Polzer, and E. H. Essington.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 1, p 69-84, July 1990. 6 fig, 3 tab, 14 ref. U. S. Nuclear Regulatory Commission Grant No. NRC/FIN/A7150.

Descriptors: \*Cobalt radioisotopes, \*Groundwater pollution, \*Mass transfer, \*Model studies, \*Path of pollutants, \*Radioactive waste disposal, \*Tuff, Adsorption kinetics, Diffusion, Radioactive wastes, Radiochemical analysis, Radioisotopes.

A factor affecting the retention of ions by solids is diffusion from the bulk of a solution to the inner portion of solid particles and the rate-determining step is either film or particle diffusion or both. The application of a shrinking-core model controlled by macropropus diffusion has been validated for apprication of a similaring-core moder controlled by macroporous diffusion has been validated for the adsorption kinetics of radioactive Co from a 0.01N CaCl2 solution to Bandelier Tuff. This tuff has served as a natural barrier in the disposal of low-level radioactive waste at Los Alamos National Laboratory. The model is validated for duplicate experiments and also in binary, and ternary combinations of the property of the complex of the controlled to the c experiments and also in binary and ternary combi-nations with Sr and Cs. The sorbates were initially in solution at 20 mg/L and were contacted with the tuff in bottles agitated in the batch mode at 25C. Co adsorbs irreversibly to the particle and is 20C. Co adsorbs irreversibly to the particle and is not available for transfer to the nonreacted portion or inner core of the particle. Unlike traditional models of rate control such as chemical reaction, film and particle diffusion, the shrinking-core model predicts increased mass-transfer rates with an increase in the concentration of Co in the liquid phase. The results have direct implications in the understanding and modeling of the fate and trans-port of radioactive Co in volcanic tuffs. Volcanic tuff is also being considered as a medium for the location of a high level nuclear waste repository in the state of Nevada. (Tappert-PTT) W91-02163

ADSORPTIVE SOLUTE TRANSPORT IN FRACTURED ROCK: ANALYTICAL SOLUTIONS FOR DELTA-TYPE SOURCE CONDI-

Kyoto Univ., Osaka (Japan). Research Reactor

Y. Fujikawa, and M. Fukui. Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 1, p 85-102, July 1990. 6 fig, 3 tab, 15 ref, 2

Descriptors: \*Adsorption kinetics, \*Fracture permeability, \*Mathematical models, \*Path of pollutants, \*Radioactive waste disposal, \*Solute transport, Analytical models, Breakthrough curves, Geologic fractures, Tracers

Solutions for adsorptive solute transport equations in a single fracture-rock system were derived under two different delta-type source conditions. One was the delta-type, flux injection condition. The correspondent solution can be used for the analysis of experimental column breakthrough curves obtained by injecting the tracer into the rock fracture. The other was the delta-type, resident fluid injection condition. The solution can be used for the crude estimation of pollutant migration from the underground radioactive waster so tion from the underground radioactive waste re-pository. In formalizing the resident fluid injection, an initial distribution of solute between solution and solid phase was assumed in order to satisfy the mass balance between injected and detected solute. Each of the two solutions was also expressed in two ways reflecting the flux and the resident fluid detection. Solutions expressed in terms of the flux detection correspond to the effluent concentration detection correspond to the eriment concentration measured experimentally by a fraction collector system. On the other hand, solutions expressed in terms of the resident fluid detection describe spatial distribution of the solute in the fluid. Since considerably long tailings of breakthrough curves are often observed in column tracer experiments using fractured rocks, effects of some parameter using tractured rocks, effects of some parameter values on the tailing were also investigated. It was shown that the adsorption of solute to rock matrix caused longer tailing. It was also shown that the resident fluid injection caused longer tailing of breakthrough curves than the flux injection condition. (Author's abstract)
W91-02164

ELECTRON MICROSCOPY DOCUMENTING THE CELLULAR METABOLIC FATE OF HG

University of Science, Penang (Malaysia). School of Biological Sciences.

For primary bibliographic entry see Field 5C. W91-02171

ELECTRON MICROSCOPY DOCUMENTING THE CELLULAR METABOLIC FATE OF ZN IONS.

University of Science, Penang (Malaysia). School of Biological Sciences. For primary bibliographic entry see Field 5C. W91-02172

ENVIRONMENTAL CHEMISTRY AND BIO-LOGICAL EFFECTS OF CADMIUM COM-

International Association of Environmental Analytical Chemistry, Therwil (Switzerland). F Merian

Toxicological and Environmental Chemistry TXECBP, Vol. 26, No. 1/4, p 27-44, 1990. 1 fig, 11 tab. 58 ref.

Descriptors: \*Cadmium, \*Heavy metals, \*Path of pollutants, \*Reviews, \*Toxicology, \*Water pollution effects, Analytical methods, Bioaccumulation, Pathology, Population ex-

The toxic metal cadmium and its compounds are The toxic metal cadmium and its compounds are distributed ubiquitously in the earth's crust. Cadmium uptake occurs by ingestion and inhalation. Smoking also plays a role, since tobacco contains cadmium. Cadmium commonly occurs as water soluble bivalent compounds and can be analyzed by atomic absorption, isotope dilution mass spectrometry, and neutron activation analytical methods. Most of the world production of cadmium is used in the electropalities of iron and steel and ods. Most of the world production of cadmum is used in the electroplating of iron and steel and manufacture of nickel-cadmium batteries; additional uses include pigments, soaps, alloys for solar cells, and neutron absorbers in nuclear power plants. In the environment, cadmium is taken up by plants much more readily than other heavy metals. High cadmium concentrations in compost, sewage sludge, and upper soil layers may reduce the num-

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bers of microorganisms necessary for rapid decomposition of organic material, and nitrogen fixation may also be reduced. Plants and fish bioaccumulate mium. Measurements of particulate airborne cadmium. Measurements of particulate airborne cadmium intake via the respiratory tract indicate retention rates of 10 to 40%, with broad variations among mammals in lung deposition and biological half-life. Detoxification is performed by cytosolic proteins such as metallothioneins. Symptoms of cadmium uptake in plants include chloroses and necroses with characteristic color changes. Increase of salinity and/or calcium content and dimicrease of sainity and/or calcium content and dimi-nution of temperature in aquatic environments de-crease cadmium toxicity. Terrestrial animals are not commonly exposed to doses that produce toxic effects. In humans, ingestion of cadmium levels higher than 15 ml/L causes vomiting. Inhalation of higher than 15 ml/L causes vomiting. Inhalation of cadmium at levels greater than 1 mg/cu meter can produce shortness of breath, weakness, and fever. Levels of 5 mg/cu meter may be lethal after eight hours exposure. There is no clear evidence for mutagenesis. Data from animal experiments suggest cadmium may have the potential to be a carcinogen, although epidemiological data is confusing and requires further study. Studies on reproductive effects and teratogenicity have mainly been conducted on rodents, and the evidence is not clear. Relatively high single cadmium doses may be treated with chelators. Threshold values are constantly being revised as more data becomes available. (Tappert-PTT)

#### **EXAMS 2: EXPOSURE ANALYSIS MODELING**

SISIEM. Bayreuth Univ. (Germany, F.R.). Chair of Ecological Chemistry and Geochemistry. For primary bibliographic entry see Field 7B. W91-02174

# ANTHROPOGENIC INFLUENCE ON THE IN-TERELEMENTAL CORRELATION IN DIF-FERENT PHASES OF THE MARINE ENVI-

Bulgarian Academy of Sciences, Varna. Inst. of

Oceanography.
G. Andreev, and V. Simeonov. Toxicological and Environmental Chemistry TXECBP, Vol. 26, No. 1/4, p 91-98, 1990. 4 fig, 3 tab. 4 ref.

Descriptors: \*Black Sea, \*Correlation analysis, \*Marine environment, \*Path of pollutants, \*Statistical methods, \*Water pollution sources, Chemical analysis, Metals, Sediments, Suspended load.

The evaluation of anthropogenic pollutants is usually based upon direct comparison of their absolute concentrations in different environmental compartments. Recent studies indicate that additional factors should be taken into account. A simple corre-lation strategy can be applied to obtain information on the anthropogenic influence in different com-partments (e.g., water, sediment, thin surface layer) of the marine environment. Seven chemical comor the marine environment. Seven themeat components (As, Se, Li, Rb, Fe, Cu, Zn) plus organic carbon and salinity were analyzed in 2200 samples collected from 21 sampling locations in the Black Sea. Samples were collected from various depths, distances from the coast, and environmental com-partments. Nine of the sampling locations were near a known pollution source. The remaining stations were located from 3 to 20 miles offshore. stations were located from 3 to 20 miles offshore. Analytical data for water, suspended matter, sediment, and thin surface layer samples were obtained. Two approaches were used to establish anthropogenic effects: (1) comparison of concentrations (traditional approach), and (2) checking of interelemental correlation changes near the pollution source. The data show that the most substantial deviation for the polluted region compared to the clean region is the increase in correlation power (i.e., the percentage of significant correlation coefficients). In clean areas the correlation maximum for water samples is found in the bottom layer, while in polluted areas the correlation maximum is found in the thin surface layer; in suspendnayer, white in politited areas the correlation maximum is found in the thin surface layer; in suspended matter the reverse is true, and in sediments the maximum for both regions is the surface layer. (Tappert-PTT)
W91-02175

MESIP: MODELLING ENVIRONMENTAL SCENARIOS IN PONDS. Bayreuth Univ. (Germany, F.R.). Chair of Ecological Chemistry and Geochemistry. For primary bibliographic entry see Field 7C. W91-02176

# SEPTIC TANK AND AGRICULTURAL NON-POINT SOURCE POLLUTION WITHIN A RURAL WATERSHED.

Texas Christian Univ., Fort Worth. Environmental

Sciences Program. S. Hayes, L. Newland, K. Morgan, and K. Dean. Toxicological and Environmental Chemistry TXECBP, Vol. 26, No. 1/4, p 137-155, 1990. 2 fig,

Descriptors: \*Agricultural runoff, \*Agricultural watersheds, \*Ammonia, \*Coliforms, \*Nonpoint pollution sources, \*Rural areas, \*Septic tanks, \*Water pollution effects, Rainfall, Soil conservation. Water pollution sources

An increased interest in water quality improvement has resulted in the creation of special programs to promote the adoption of soil conservation practices. Non-point source (NPS) pollution derived from sediment infusion is specifically adressed in the latest version of the Clean Water Act. The Lake Weatherford reservoir in Parker County. Texas is the prignary supprised approximation of the county. Act. The Lake Weatherford reservoir in Parker County, Texas is the primary municipal water supply for the City of Weatherford, Texas. The principal method of wastewater disposal is the onsite system or septic tanks for the small residential areas surrounding the reservoir. Sources of NPS pollution of interest in this watershed include agricultural operations as well as the residential areas. These sites were identified with the aid of aerial photography and field investigation. Suspected NPS problems were substantisted through a sampling program involving chemical and biological testing of the reservoir. Results indicate that there is significant NPS pollution contamination of Lake testing of the reservoir. Results indicate that there is significant NPS pollution contamination of Lake Weatherford from agricultural sources and seepage from on-site wastewater disposal systems. Excessive fecal coliform and fecal streptococcus counts were generally associated with rainfall events, and several samples showed values greater than 100,000 bacteria per 100 ml. The fecal coliform/fecal streptococcus ratios indicated contamination from human sources, and a combining of the property of the prop from human sources, animal sources, and a combi-nation of both. Nutrient concentrations fluctuated from quite low to high with ammonia as the most consistent problem. High ammonia values were also associated with rainfall events. (Author's abstract) W91-02177

### TRACE METALS IN THE WESTERN MEDI-

TERRANEAN SEA.
Istituto di Biofisica, Pisa (Italy).
A. Seritti, E. Morelli, L. Nannicini, and G.

Toxicological and Environmental C TXECBP, Vol. 26, No. 2/3, p 87-93, 1990.

Descriptors: \*Cadmium, \*Copper, \*Lead, \*Medi-terranean Sea, \*Path of pollutants, \*Trace metals, \*Water pollution sources, Data collections, Distri-bution patterns, Particulate matter, Seawater, Water sampling.

Data on Cd, Pb, and Cu concentrations in seawater were determined from samples collected during five years of field studies in the western Mediterrafive years of field studies in the western Mediterranean Sea. The data present a space and time integrated status of the levels of these metals. Sampling locations included areas near known sources
of industrial discharges. Surface total metal concentrations present rather homogeneous distributions over the different areas considered, including
the Tyrrhenian Sea (off Italy in the eastern part of
the study area). The metal concentrations in three
areas affected by natural and industrial wastes are
not significantly different from data reported from
other areas of the Mediterranean. Averages and
ranges of metal concentrations found in particulate
matter in the Tyrrhenian Sea seem to be rather
low, although the ranges are larger than those in
the dissolved fraction, particularly for Po and Cu.
The data indicate the high affinity of metals for

particulate matter. The vertical distribution of dis-solved Cd, Pb, and Cu in the Alboran Sea (in the solved Cd, Ph, and Cu in the Alboran Sea (in the western part of the study area, between Spain and North Africa) seems to be rather homogeneous, both vertically and along a series of stations between the Strait of Gibraltar and the island of Alboran. (Tappert-PTT) W91-02179

# MODELING OF MULTICOMPONENT TRANS-PORT WITH MICROBIAL TRANSFORMA-TION IN GROUNDWATER: THE FUHRBERG

Waterloo Univ. (Ontario). Inst. for Ground Water

E. O. Frind, W. H. M. Duynisveld, O. Strobel, and J. Boettcher.

Water Resources Research WRERAQ, Vol. 26, No. 8, p 1707-1719, August 1990. 16 fig, 26 ref.

Descriptors: \*Biodegradation, \*Fate of pollutants, \*Groundwater pollution, \*Microbial degradation, \*Model studies, \*Path of pollutants, \*Solute transport, Aquifer characteristics, Finite element method, Groundwater management, Nitrates, Water resource management.

A numerical technique has been developed that appears to have potential in studies of nonlinear reactive transport problems, and it is applied to a case study where the implications of reactive transcase study where the implications of reactive transport processes are profound. The case study relates to the Fuhrberger Feld aquifer in northern Germany, which provides the bulk of the water supply for the half-million people living in the city of Hannover. Part of the aquifer receives a strong influx of nitrate from agricultural activities. The nitrate in the aquifer is microbially transformed into sulfate, the transformation depending on the availability of reduced sulfur compounds present in the sediment. The individual transformations occur. the sediment. The individual transformations occur within distinct reaction zones in the aquifer. relevant dynamic processes can be formulated as a nonlinear transport problem involving multiple interacting species in dissolved or solid form. The system is simulated using a finite element-based technique that generates a symmetric coefficient matrix for the transport equation, while providing second-order accuracy in time. The form of the matrix allows the use of a highly efficient and robust symmetric conjugate gradient solver. The technique provides an ample spatial resolution capacity at reasonable cost, and handles grids with irregular geometry in two or three dimensions. The convenience and versatility of conventional finite elements is retained. A vertical-section simulation identifies different reaction zones in the aquilibro identifies different reaction zones in the aquirelevant dynamic processes can be formulated as a nunce elements is retained. A vertical-section simulation identifies different reaction zones in the aquifer and gives insight into the effect of the controlling parameters. The simulation study is a first step in the development of a prognosis for the fate of the groundwater resource. (Author's abstract) W91-02180

# THREE-DIMENSIONAL STATISTICAL MOMENT ANALYSIS OF THE STANFORD/WATERLOO BORDEN TRACER DATA.

Western Australia Univ., Nedlands. Centre for Water Research.

water Research.
D. A. Barry, and G. Sposito.
Water Resources Research WRERAQ, Vol. 26,
No. 8, p 1735-1747, August 1990. 4 fig, 3 tab, 50 ref. NSF Grant ECE-8513726.

Descriptors: \*Groundwater pollution, \*Ontario, \*Path of pollutants, \*Statistical analysis, \*Tracers, Bromine, Canada, Military reservations, Plumes, Statistical methods, Stochastic models.

The bromide plume at the Borden site (Ontario, Chanda) has been extensively investigated by re-searchers from Stanford University and the Uni-versity of Waterloo. Seven solutes, including Br and Cl, were injected into the Borden aquifer in 1982. Chemical data was collected at varying inter-vals up to an elapsed time of 1038 days. The data has been used to estimate the mass, mean position vector, and covariance tensor of the bromide plume. A number of interpretive steps was necessary to compute these plume moments. First, the spatially scattered data were interpolated onto a

#### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 58—Sources Of Pollution

regular grid, with the interpolator selected on the basis of a cross-validation criterion. The moment estimates then could be calculated readily, although it was recognized that the interpolation procedure can lead to bias in the moment estimates. For this reason, reduced-bias, jackknifed estimates of the moments, as well as confidence intervals for these estimates, were derived. The intervals for insel estimates, were derived. The total plume variance also was estimated with the jackknife method. The latter results were compared with the prediction of a recent stochastic model developed by Dagan (1988). When this model was applied in a completely predictive mode, a remarkably good estimate of the total plume variance resulted. (Author's abstract) W91-02182

UNIVERSAL SCALING OF HYDRAULIC CON-DUCTIVITIES AND DISPERSIVITIES IN GEO-

LOGIC MEDIA.

Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.

For primary bibliographic entry see Field 2F.

W91-02183

VARIABILITY IN CONCENTRATIONS OF SE LECTED TRACE ELEMENTS IN WATER AND SEDIMENT OF SIX ACIDIC LAKES.

Cook Coll., New Brunswick, NJ. Dept. of Envi-

ronmental Science

ronmental Science.

M. Sprenger, A. McIntosh, and T. Lewis.
Archives of Environmental Contamination and
Toxicology AECTCV, Vol. 16, No. 4, p 383-390,
July 1987. 4 fig. 5 tab, 19 ref.

Descriptors: \*Acid lakes, \*Acid rain effects, \*Aluminum, \*Cadmium, \*Lead, \*Manganese, \*Water pollution sources, \*Zinc, Chemical analysis, Heavy metals, Hydrogen ion concentration, Lake sediments, New Jersey, Pollutant identification, Seasonal variation, Sediment analysis, Sediment contamination, Trace metals.

Concentrations of the trace elements Al, Cd, Pb, Mn and Zn were determined in water and sediments of six acidic clear-water lakes (pH 3.6-6.2) in northwestern New Jersey. Levels of Al, Pb and Zn in the water column were sharply elevated in the most acidic lakes, with values similar to acidified systems elsewhere. Seasonal fluctuations occurred, with Pb displaying peak concentrations in all lakes during the fall sampling period. Analyses of core samples of lake sediment indicated that while Pb concentrations exhibited a typical sharp increase in most recent sediments, Cd and Zn levels in the upper layers were substantially lower than values reported for similar systems elsewhere. As expected, Mn concentrations generally decreased in the upper sediment layers in the acidic lakes, while Al ried dramatically between systems. (Author's abstract) W91-02193

RESIDUE LEVELS OF ORGANOCHLORINE CHEMICALS AND POLYCHLORINATED BI-PHENYLS IN FISH FROM THE ALEXANDRIA REGION, EGYPT.

REGION, EGYPT.

Institute of Oceanography and Fisheries, Alexandria (Egypt). Dept. of Marine Pollution Research.

A. El Nabawi, B. Heinzow, and H. Kruse.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 6, p 689-696, November 1987. 3 fig, 6 tab, 25 ref.

Descriptors: "Chlorinated hydrocarbons, "Fish, "Path of pollutants, "Pesticide residues, "Polychlorinated biphenyls, Abu Qir Bay, Chemical analysis, Coastal waters, DDD, DDE, DDT, Egypt, Endosulfan, Fate of pollutants, Gas chromatography, Lake Idku, Lake Maryut, Lakes, Marine environment, Methoxychlor, Tilapia, Tissue analysis.

Residues of polychlorinated biphyenyls (PCBs) and organochlorine chemicals were analyzed by capillary gas chromatography in five fish species (Pagellus erythrinus, Sargus vulgarius, Siganus ri-vulatus, Sphyraena sphyraena and Trigia hirundo) from Abu Qir Bay as well as in Tilapia species from Idku and Maryut lakes in Alexandria, Egypt. Total DDT and PCBs were the most predominant contaminants occurring in the muscle tissue of all fish samples. Remarkable variations in the concen-trations of PCBs were noted among the species, and the concentrations of total DDT were higher than that of PCBs in all fish species. Elevated PCB concentrations were observed in muscle tissue of concentrations were observed in muscle tissue of S. vulgarius from Abu Qir Bay, and in Tilapia zillii from Forn El-Gieraia, Maryut lake. Also, vari-ations were found in the relative proportions of p.p'-DDT, p.p'-DDD and p.p'-DDE in all fish-samples. The results revealed an increase in chlor-inated hydrocarbons with increase in body size and fat content. Neither alpha-endosulfan nor beta-endosulfan was detected in fish from Abu Qir Bay; however, only alpha-endosulfan was detected in trace amounts in Tilapia species from Idku and Maryut lakes. With the exception of S. vulgarius, mirex and methoxychlor occurred in low levels in all other fish species. From a public health standpoint, residue levels of organochlorines and PCBs in all fish samples analyzed are considerably lower than known tolerance levels; however, there is an increasing need for monitoring of these contaminants to insure the protection of food sources. (Author's abstract) fat content. Neither alpha-endosulfan nor beta-en-(Author's abstract) W91-02197

EFFECTS OF ENVIRONMENTAL PARAM-ETERS ON THE ELIMINATION OF CADMI-UM BY EASTERN OYSTERS, CRASSOSTREA

National Marine Fisheries Service, Charleston, SC. Southeast Fisheries Center.
F. M. Van Dolah, T. C. Siewicki, G. W. Collins,

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 6, p 733-743, November 1987. 2 fig. 6 tab, 27 ref.

Descriptors: \*Cadmium, \*Heavy metals, \*Humic acids, \*Oysters, \*Path of pollutants, \*Salinity, \*Temperature effects, \*Toxicology, Animal metabolism, Cadmium radioisotopes, Chelating agents, Chemical analysis, Copper, Fate of pollutants, Iron, Laboratory methods, Magnesium, Trace metals, Zinc.

Laboratory studies were conducted to test the effects of salinity, humic acid and temperature on the rate of elimination of Cd109 from laboratory-dosed juvenile oysters, Crassostrea virginica. After 140 days, oysters maintained at 34 parts per thousand (ppt) salinity retained 67% of the Cd109 dose (CPM), oysters in 20 ppt salinity retained 72% and those in 6 ppt salinity retained 80%. The presence of humic acid in 14 ppt salinity water enhanced the amount of Cd109 eliminated in 140 days relative to oysters in control tanks without humic acid; oysters exposed to 10 parts per million (norm) humic oysters in control tanks without nume acid; oys-ters exposed to 10 parts per million (ppm) humic acid retained 65%, oysters exposed to 1 ppm humic acid retained 67%, controls retained 72%. Temperature had a significant effect on the rate of Temperature had a significant effect on the rate of Cd elimination. Oysters held at 28 degrees and 20 ppt for 28 days retained 75%, oysters at 20 degrees and 20 ppt retained 81% and those at 12 degrees and 20 ppt retained 88% of Cd109 dose. The effects of a strong Cd-chelator, ethylenediamine tetraacetic acid-sodium salt (EDTA) were compared with those of the relatively weaker chelator, numic acid, on the rate of Cd elimination by oysters. No difference was observed between the two chelators over a 28 day depuration period. Cadmium concentrations were monitored in the water and Cd, Cu, Zn, Mg and Fe concentrations were determined in the animals on the final day of the determined in the animals on the final day of the determined in the animals on the final day of the studies. Tissue Zn concentrations behaved similarly to tissue Zn concentrations, while Cu and Fe behaved oppositely from those of Cd and Zn. Mg correlated with salinity. Particle clearance assays were performed to determine if the rate of filtration by the oysters held in each of the test treatments correlated with the rates of Cd depuration. No direct correlation was observed. (Author's abstract) stract) W91-02198

SHORT-TERM LETHALITY AND SEDIMENT AVOIDANCE ASSAYS WITH ENDRIN-CONTAMINATED SEDIMENT AND TWO OLIGO-CHAETES FROM LAKE MICHIGAN.
Michigan Univ., Ann Arbor, Great Lakes ReFor primary bibliographic entry see Field 5C. W91-02199

DETECTION OF ORGANOPHOSPHORUS PESTICIDE DETOXIFYING BACTERIAL COLONIES, USING UV-PHOTOGRAPHY OF COLONIES, USING OV-PHOTOGRAPHY OF PARATHION-IMPREGNATED FILTERS.
Texas A and M Univ., College Station. Dept. of Biochemistry and Biophysics.
C. S. McDaniel, and J. R. Wild.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 2, p 189-194, March 1988. 3 fig, 1 tab, 13 ref.

\*Biodegradation, \*Detoxification, Descriptors: "Biodegradation, "Detoxitication, "Fate of pollutants, "Laboratory methods, "Micro-bial degradation, "Organophosphorus pesticides, "Parathion, "Pesticides, Bacterial physiology, Fil-tration, Microbiological studies, Photography, Plasmids, Pseudomonas, Ultraviolet radiation.

A rapid filter-lift assay was developed for the identification of bacteria capable of degrading organophosphorus pesticides. Filter pads impregnated with parathion were applied to the surface of plates containing potential parathion-degrading colonies. Positive colonies capable of converting parathion to 4-nitrophenol attain a visible yellow coloration after 30 min of exposure; however, the identification of selected individuals was difficult identification of selected individuals was unneum when large numbers of colonies were screened on a single plate. An enhancement of this screening method was achieved with the use of UV-photogmethod was achieved with the use of UV-photography, which allowed for the detection of a single mutant or cured colony among 500 parathion-degrading colonies per plate. In addition, it was possible to detect a single parathion-degrading colony among 10000 non-degrading colonies per plate. The efficiency of the technique was validated with a parathion-degrading strain of Pseudomans diminuta from which phenotypically negative isolates were selected, subjected to plasmid monas diminuta from which phenotypically negative isolates were selected, subjected to plasmid isolation, evaluated for detoxifying activity, and tested by a battery of microbiological criteria toonfirm the parental strain phenotype. All non-productive colonies were identical to the parental strain except for the lack of detoxifying capability and the loss of a large plasmid found in the parental strain. (Author's abstract) W91-02200

SLOWLY REVERSIBLE SORPTION OF ALI-PHATIC HALOCARBONS IN SOILS, I. FOR-MATION OF RESIDUAL FRACTIONS.

Connecticut Agricultural Experiment Station, New Haven. Dept. of Soil and Water.

J. J. Pignatello. Environmental Toxicology and Chemistr ETOCDK, Vol. 9, No. 9, p 1107-1115, September 1990. 3 fig, 5 tab, 22 ref.

Descriptors: \*Adsorption-desorption, \*Fate of pol-lutants, \*Halogenated hydrocarbons, \*Path of pol-lutants, \*Soil contamination, Chemical analysis, Desorption, Laboratory methods, Loam, Soil anal-ysis, Soil physics, Soil types.

The formation of slowly reversible sorbed frac-The formation of stowy reversible sorbed frac-tions of various halogenated alkanes and alkenes in two surface soils (Cheshire fine sandy loam and Agawam fine sandy loam) was studied. After the initial sorption equilibration period, the compounds were desorbed by one of two methods. The first used repetitive batch extraction with water. After used repetitive outer extraction with water. After 16 extractions of 24 to 72 h each, concentrations in the aqueous phase reached low values and a slow desorbing, residual fraction remained in the soil. The residual fraction in the soil was determined independently after extraction with hot acctone, where efficacy was demonstrated. During descriptions are supported to the contracted programme and the contracted program independently after extraction with hot acetone, whose efficacy was demonstrated. During desorption, apparent soil-water distribution coefficients increased progressively to as much as 200 times greater than equilibrium sorption coefficients, Kd, obtained separately from sorption isotherms. With increasing sorption equilibration time, the residual became greater in magnitude and less mobile. The second desorption method simulated desorption in infinite dilution over a 96 h period by using Tensy. infinite dilution over a 96 h period by using Tenax GC polymeric adsorbent beads included in the

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suspension as a sink for desorbed chemical. Control experiments proved the usefulness of Tenax and showed that desorption from the soil was rate limiting. All compounds studied formed slowly reversible fractions in the soils. This fraction amounted to several percent of the total sorbed amounted to several percent of the total sorbed from solution. The results indicate that formation of slowly reversible fractions is probably typical of nonpolar organic compounds, including those with weak sorbing tendencies. (See also W91-02210) (Author's abstract) W91-02200

SLOWLY REVERSIBLE SORPTION OF ALI-PHATIC HALOCARBONS IN SOILS. II. MECHANISTIC ASPECTS. Connecticut Agricultural Experiment Station, New Haven. Dept. of Soil and Water. J. J. Fignatello. Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 9, p 1117-1126, September 1990. 6 fig, 4 tab, 27 ref.

Descriptors: \*Adsorption-desorption, \*Fate of pollutants, \*Halogenated hydrocarbons, \*Path of pollutants, \*Soil contamination, Chemical analysis, Desorption, Laboratory methods, Loam, Sediment analysis, Soil organic matter, Soil physics, Soil types.

analysis, Sediment chemistry, Soil analysis, Soil organic matter, Soil physics, Soil types.

The mechanism of formation and release of highly immobilized residues of some small nonpolar halogenated hydrocarbons in two surface soils (Cheshire fine sandy loam and Agawam fine sandy loam), a stream sediment and an aquifer sediment was investigated. The labile sorbed fractions of the compounds were removed from treated soils by purging to infinite dilution in aqueous suspensions for 96 h. The remaining slowly reversible (residual) compound fraction in the soil was quantitated as a function of prepure sorption conditions. The residual increased nonlinearly with sorption equilibration time and applied concentration. Residuals in whole soils and whole soils pretreated with H2O2 were correlated with soil organic carbon. Among wet-sieved particle size fractions, however, the organic carbon-based concentrations followed the order sand > silt >> clay. Also, some residual was associated with undecomposed plant matter. Release of the residual into water was greatly increased by pulverization of the soil and by acidification of the soil suspension. The results indicate that the slow release of the residual fraction is caused by molecular diffusion from remote sites in the soil organic matter matrix. Mineral surface and clay interlayer adsorption were ruled out by the finding of low residuals in the clay-sized particles. However, the mineral fraction plays an important role by shielding some of the organic matter in interstitial pores of particle aggregates from equilibrium with bulk solution. (See also W91-02210

PREDICTING CONCENTRATIONS OF CON-SUMER PRODUCT CHEMICALS IN ESTU-

ARIES.
Virginia Univ., Charlottesville. Dept. of Civil En-

gineering.
W. S. Lung, R. A. Rapaport, and A. C. Franco.
Environmental Toxicology and Chemistry
ETOCDK, Vol. 9, No. 9, p 1127-1136, September
1990. 10 fig, 23 ref.

Descriptors: \*Computer models, \*Estuaries, \*Estuarine environment, \*Expert systems, \*Fate of pollutants, \*Path of pollutants, \*Solute transport, Alzylenznen sulfonates, Biochemical oxygen demand, Computers, Flow models, Industrial wastes, Low flow, Mathematical models, Municipal wastes, Organic carbon, Salinity, Seasonal variation.

About 25 to 30% of all United States publicly-owned treatment works (POTW) discharges enter estuaries and coastal waters. An expert system has been developed to model the fate and transport of chemicals discharged from POTWs into estuaries. Each POTW has been classified as one of four groups: primary, trickling filter, lagoon and acti-vated sludge in terms of treatment level. The

system is designed to calculate concentrations under 7-d 10-year low flow, summer low flow and annual mean flow conditions. To account for vary-ing mixing characteristics and salinity distributions ing mixing characteristics and salinity distributions observed in a given estuary, the system includes one-dimensional and two-dimensional (longitudinal and vertical) mass transport algorithms. To date, the modeling framework has been applied to nine estuaries. For validation purposes, biochemical oxygen demand (BOD) concentrations are also predicted based on industrial as well as municipal organic carbon loads. In several estuaries, predicted in-stream BOD levels have been compared to measured BOD data resulting in successful model validation. The validated models are then used to predict linear alkylbenzene sulfonate (LAS) concentrations in estuaries. These LAS concentrations are found to be less than 20 micrograms/L in these are found to be less than 20 micrograms/L in these estuaries under the three flow conditions. (Author's abstract) W91-02211

GEOCHEMISTRY OF BATCH-EXTRACT WATERS DERIVED FROM SPOIL MATERIAL COLLECTED AT THE CORDERO COAL MINE, POWDER RIVER BASIN, WYOMING, Geological Survey, Cheyenne, WY. Water Re-

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4200, 1990. 58p, 21 fig, 14 tab, 26 ref.

Descriptors: \*Geochemistry, \*Mine wastes, \*Model studies, \*Powder River Basin, \*Water pollution effects, \*Water pollution sources, \*Water quality, \*Wyoming, Coal mining, Mineralogy.

Batch-mixing experiments to evaluate postmining water quality, at the Cordero Mine were conducted by the U.S. Geological Survey during 1984 to 1985. Contact of groundwater from the spoil aquifer with fresh spoil material caused only small changes in major-element concentrations and in pH, unless sulfide oxidation or contact with soluble salts, such as epsomite, occurred. In contrast, large changes in major-element concentration resulted when water from the coal aquifer contacted the spoil material. Only three of seven reaction models considered to explain the water quality changes during the batch-mixing experiments were consistent with the thermodynamic and mineralogical data. The three models used to account for the observed water quality changes derived potassium from potassium feldspar, magnesium from chlorite or epsomite or both, sodium from cation exchange and halite, chloride from halite, silica from potassium feldspar and chlorite; sulfate from gypsum, or epsomite or both, and carbon from carbon dioxide. In general, water quality samples obtained from the batch-mixing experiments using water from the coal aquifer had smaller major-ion concentrations than the actual water quality in the spoil aquifer. These differences can be explained by the limited amount of efflorescent salt dissolution and volume of water used in the experiments. Correction ratios calculated for these experiments may be applied to batch-mixing experiments at other mines in the area, to predict postmining water quality. (USGS) W91-02222

HYDROLOGY OF GOAT LAKE WATERSHED, SNOHOMISH COUNTY, WASHINGTON, 1982-

87. Geological Survey, Tacoma, WA. Water Resources Div. N. P. Dion, J. C. Ebbert, J. E. Poole, and B. S.

Peck.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Water-Resources Investigations Report 88-4235, 1989, 44p, 11 fig, 8 tab, 36 ref.

Descriptors: \*Acid rain, \*Goat Lake, \*Mountain lakes, \*Washington, \*Water quality, Acid rain effects, Acidification, Alkalinity, Water pollution sources, Watersheds, Yield.

The Goat Lake watershed in Snohomish County, Washington, functions as an 'experimental water-

shed' for long-term studies to determine the effects of acidic precipitation on water resources. Data have been collected there by the U.S. Geological Survey since 1982. The watershed is in a wilder-ness area of the Cascade Range and is downwind Survey since 1982. The watershed is in a wilderness area of the Cascade Range and is downwind
of an industrial and urban area that produces
chemical compounds found in acidic precipitation.
The lake is considered sensitive to acidic inputs
from atmospheric deposition and streamflow. The
mean annual discharge of the Goat Lake outflow is
35 cu ft/sec; precipitation on the watershed is
calculated to be about 170 in/yr. The inflow to
Goat Lake is sufficient to replace the entire contents of the lake basin on an average every 21.5
days, or 17 times/year. Water in Goat Lake, and
that of the inlet and outlet, is of low ionic strength
and of calcium-bicarbonate type. The lake, although considered oligotrophic, is sufficiently
deep to stratify thermally, and summer dissolvedoxygen concentrations in the hypolimnion are depressed. Even though alkalinity and specific conductance at Goat Lake are in the range considered
sensitive to acidic inputs, the pH of water in the
lake has consistently ranged from 6.1 to 7.2, indilake has consistently ranged from 6.1 to 7.2, indi-cating that the lake is not acidified at this time. (USGS) W91-02227

U. S. GEOLOGICAL SURVEY APPLIED RE-SEARCH STUDIES OF THE CHEYENNE RIVER SYSTEM, SOUTH DAKOTA: DESCRIP-TION AND COLLATION OF DATA, WATER YEARS 1987-88.

YEARN 1997-88. Geological Survey, Rapid City, SD. Water Resources Div. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-580, 1990. 145p, 9 fig, 52 tab.

Descriptors: \*Cheyenne River, \*Hydrologic data, \*Mine wastes, \*Path of pollutants, \*South Dakota, \*Water pollution sources, \*Water quality, Adsorption-desorption, Analytical techniques, Biology, Sediment chemistry.

Sediment chemistry.

The Cheyenne River System in western South Dakota has been impacted by the discharge of about 100 million metric tons of gold-mill tailings to Whitewood Creek near Lead, South Dakota. In April 1983, the U.S. Geological Survey initiated an extensive series of research studies to investigate the magnitude of the impact and to define important processes acting on the contaminated sediments present in the system. The report presents all data collected during the 1987 and 1988 water years for these research studies. Some of the data included have been published previously. Data collected in the 1985 and 1986 water years have been published in a companion report (U.S. Geological Survey Open-File Report 88-484). Hydrologic, geochemical, and biologic data are available for sites on Whitewood Creek, and the Belle Fourche and Cheyenne Rivers. Data complexity varies from routine discharge and water-quality to very complex energy-dispersive x-ray analysis. Methods for sample collection, handling and preservation, and laboratory analysis are also presented. No interpretations or complex statistical summaries are included. (See also W89-08390) (USGS)

WATER-QUALITY, WELL CONSTRUCTION, AND GROUNDWATER LEVEL DATA FOR AN INVESTIGATION OF RADIONUCLIDES IN GROUND WATER, HICKMAN AND MAURY COUNTIES, TENNESSEE. Geological Survey, Nashville, TN. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-02238

AGRICULTURAL PESTICIDES AND GROUNDWATER IN NORTH CAROLINA: IDENTIFICATION OF THE MOST VULNERA-

North Carolina Water Resources Research Inst., Raleigh. nary bibliographic entry see Field 5G.

#### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 5B-Sources Of Pollution

HYDROGEOLOGIC RECONNAISSANCE OF THE SWOPE OIL SUPERFUND SITE AND VI-CINITY, CAMDEN AND BURLINGTON COUNTIES, NEW JERSEY.

Geological Survey, Trenton, NJ. Water Resources

For primary bibliographic entry see Field 2F. W91-02249

SOURCE, EXTENT, AND DEGRADATION OF HERBICIDES IN A SHALLOW AQUIFER NEAR HESSTON, KANSAS.

NEAR HESSTON, KANSAS.
Geological Survey, Lawrence, KS. Water Resources Div.
C. A. Perry.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4019, 1990. 24p, 10 fig, 7 tab, 14 ref. USGS Project No. KS151 KS151.

Descriptors: \*Degradation, \*Fate of pollutants, \*Groundwater pollution, \*Herbicides, \*Kansas, \*Path of pollutants, \*Water pollution sources.

Atrazine, alachlor, cyanazine, metolachlor, and metribuzin were detected in water from a domestic metribuzin were detected in water from a domestic well completed in a shallow aquifer underlying the Harvey County Experiment Field near Hesston, Kanssa. The study described in this report investigated the source, extent, and degradation of these five herbicides. Hydrogeologic analysis of the site enabled estimation of the degradation half-lives of the herbicides in the saturated zone. The most probable source of the contamination was backsiphonage or spillage of herbicides from a sprayer tank into a trench backfilled with sand. The herbicides moved downgradient to the domestic well cides moved downgradient to the domestic well and then moved into the aquifer via the annular space in the well. Once in the aquifer, the contaminants remained nearly stationary with very little lateral movement away from the point of injection. Decreases in herbicide concentrations were caused mainly by degradation of the parent compounds mainty by degradation of the parent compounds and to a lesser degree, by extensive pumping of the well. Estimated herbicide degradation half-lives in the saturated environment were 1,000 days for atrazine, 400 days for alachlor, 250 days for cyanazine, 350 days for metolachlor, and 350 days for metribuzin. The herbicides will likely be eliminated from the soil and groundwater at the experiment field by continued natural degradation at the land surface and by degradation in and continued pumping of water from the aquifer. Pumping will remove any degradation products as well as the remaining parent compounds. (USGS) W91-02225

GEOHYDROLOGY AND GROUNDWATER GEOCHEMISTRY AT A SUB-ARCTIC LAND-FILL, FAIRBANKS, ALASKA.

Geological Survey, Anchorage, AK. Water Resources Div.

sources Div.

J. S. Downey, and P. O. Sinton.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4022, 1990. 25p, 21 fig, 2 tab, 11 ref.

Descriptors: \*Alaska, \*Geohydrology, \*Landfills, \*Path of pollutants, \*Water pollution sources, Biological processes, Cold regions, Water chemistry.

The Fairbanks-North Star Borough, Alaska, landfill is located on silt, sand, and gravel deposits of the Tanana River flood plain, about 3 miles south of the city of Fairbanks water supply wells. The landfill has been in operation for about 25 years in inform has been in operation for about 25 years in this sub-arctic region of discontinuous permafrost. The cold climate limits biological activity within the landfill with corresponding low gas and leach-ate production. Chloride concentrations, specific conductance, water temperature, and earth con-ductivity measurements indicate a small plume of ductivity measurements indicate a small plume of leachate flowing to the northwest from the landfill. The leachate remains near the water table as it flows northwestward toward a drainage ditch. Re-sults of computer modeling of this local hydrologic system indicate that some of the leachate may be discharging to the ditch. Chemical data show that higher-than-background concentrations of several ions are present in the plume. However, the con-centrations appear to be reduced to background levels within a short distance along the path of groundwater flow from the landfill, and thus the leachate is not expected to affect the water supply wells. (USGS) W91-02253

GROUNDWATER QUALITY IN RURAL AREAS IN WESTERN AFRICA.

International Bank for Reconstruction and Development, Abidjan (Ivory Coast). Regional Water For primary bibliographic entry see Field 2F.
W91-02336

VULNERABILITY OF THE BRAZZAVILLE AQUIFER AND THE RISK OF CONTAMINATION WITH DOMESTIC WASTES (PROBLEMES DE VULNERABILITE DE LA NAPPE DE BRAZZAVILLE ET RISQUES DE CONTAMINATION PAR LES REJETS DOMESTI-

Institut Français de Recherche Scientifique pour le Developpement en Cooperation, Bri (Congo). Centre ORSTOM de Brazzaville. N. Moukolo.

N. Moukolo.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 605-626, 11 ref, append. English

Descriptors: \*Congo, \*Developing countries, \*Domestic wastes, \*Groundwater pollution, \*Human diseases, \*Wastewater pollution, \*Water pollution sources, Aquifer characteristics, Path of pollutants, Sanitation, Water supply, Wells.

Sanitary and social conditions prevailing in the outskirts of Brazzaville (Congo) are a cause of concern and are linked to the poor quality of drinking water. In areas not fitted with a water supply system, waterborne diseases such as amoebiasis, bacillary dysentery, and diarrhea are the prime causes of morbidity. A fact-finding operation was initiated in 1985 to determine the effects of pollution on the underground water surrounding Brazzaville. Thirty water wells (sources and fountains included) were selected and checked. Type of well, location of well, design parameters, past and tains included) were selected and checked. Type of well, location of well, design parameters, past and present use of the well, and the possibility of obtaining data were determined in a preliminary phase of the project. These wells are regularly checked and physical, chemical, and bacteriological analyses of their water are conducted. Industrial waste is unknown around Brazzaville; agriculan waste is unknown around brazzavine; agriculture is confined to non-intensive gardening and chemical fertilizers and pesticides are used rarely. Pollution of domestic origin is the most important source and accounts for 70% of the cases of contamination of the aquifer as revealed by the prelim-inary results of this study. (See also W91-02288) (Author's abstract) /91-02339

PROBLEMS OF MAINTENANCE OF WATER QUALITY IN ARID AND SEMI-ARID RE-GIONS OF WEST AFRICA.

Ghana Univ., Legon. Dept. of Botany. For primary bibliographic entry see Field 5G. W91-02348

IMPACTS OF URBAN WASTE ON SURFACE WATER IN OUAGADOUGOU AND BOBODIOULASSO (BURKINA FASO) (IMPACTS DES REJETS URBAINS SUR LES EAUX DE SURFACE A OUAGADOUGOU ET BOB-DIOU-LASSO (BURKINA FASO)). Centre National de la Recherche Scientifique et Technologique, Ouagadougou (Burkina Faso).

J. N. Poda. In: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Il-

linois. 1990. p 976-986, 1 fig, 3 tab, 8 ref. English

Descriptors: \*Burkina Faso, \*Human diseases, \*Public health, \*Urban, \*Wastewater pollution, \*Water pollution sources, Developing countries, Domestic water, Hydrogen ion concentration, Monitoring, Municipal wastes, Municipal water, Path of pullutants, River We, Sanitation, Water chemistry, Water quality trends.

Water presents a crucial problem in Burkina Faso for two reasons: its scarcity and its unsanitary condition in both the towns and the countryside. One of the consequences of development of urban centers is the significant production of water for domestic and industrial consumption. The contami-nation of aquatic systems that results from this is indicated by modification of physical, chemical, and biological characteristics and by the frequency and biological characteristics and by the frequency of illnesses resulting from poor water quality. This phenomenon was studied in Burkina Faso through observations of the evolution of pH in the River observations of the evolution of pri in the River We in Bobo-Dioulasso, its ionic composition, and the productivity of reservoir waters in Ouagadou-gou. Overall, the mineral and organic contribution of wastes in the surface waters in Ouagdougou and of wastes in the surface waters in Ouagdougou and Bobo-Dioulasso seems to favor development of aquatic life and because of it, a certain self-purification of these waters occurs. In the long term. This concentration of pollution would endanger the biological equilibrium. The surface waters in towns could become a favorable medium for concentration and expansion of serious microbial illnesses because these waters are often used directly for domestic consumption. (See also W91-02288) (Author's abstract) W91-02369

BIOLOGICALLY AVAILABLE PHOSPHORUS RETENTION BY THE KIS-BALATON RESER-

Ulster Univ., Coleraine (Northern Ireland). Limnology Lab. For primary bibliographic entry see Field 2H. W91-02375

WATER QUALITY IN RESERVOIRS: THE EFFECT OF INFLOWING POLLUTION.

Vyzkumny Ustav Vodohospodarsky, (Czechoslovakia). E. Kockova.

Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 827-829, 1990. 2 tab, 3 ref.

Descriptors: \*Czechoslovakia, \*Limnology, \*Reservoirs, \*Water pollution sources, \*Water quality, Ammonium, Biological oxygen demand, Dissolved oxygen, Lentic environment, Organic matter, Phytoplankton

In the Brno Water Research Institute, Czechoslovakia, research in surface water pollution has been directed towards two localities. The first system of reservoirs is that of Nove Mlyny situated at the confluence of the Dyje, Jihlava and Svratka rivers in the South Moravian region. The inflowing water of the Dyje is contaminated with high levels of organic compounds as indicated by BOD5, and also with mineral components. The water often contains minimal concentrations of dissolved oxygen (DO) or even no oxygen at all. Fecal contamination is responsible for the constant presence of ammonium ion. The BOD5 value averaged 23 mg/L in 1986; in the last 5 years the load of inflowing water fluctuated between 15 and 20 tons/day BOD5. The oxygen regime is influenced by many other factors such as the intensive growth of phytoplankton, resulting in the oversaturation of water during the summer days. Overnight and in In the Brno Water Research Institute, Czechosloof phytoplankton, resulting in the oversaturation of water during the summer days. Overnight and in the morning the phytoplankton draws on the oxygen until its concentration reaches zero. Owing to the small depth the stagnant water has no oxygen at all in the bottom zone, and in recent years this has often led to fish kills. The incoming contamination, sedimentation of the organic matter, and other effects have a negative impact in the upper third of the reservoir, which is dominated by the decrease in DO. In the second locality, the Dalesice reservoir, the inflowing water of the

#### Sources Of Pollution-Group 5B

river Jihlava contains high concentrations of DO, with an average BODS of 10 mg/L; during 1980-83 the load of the inflow-profile fluctuated between 3.35 and 9.32 tons/day BODS. Although this reservoir is substantially less contaminated than the Nove Mlyny reservoir, the general trend of the water quality has not been satisfactory, especially in relation to the oxygen regime. Neither the motion of the water surface nor turbine and numning operations have substantially affected the the motion of the water surface nor turbine and pumping operations have substantially affected the oxygen balance of the whole water column. Conse-quently, in this reservoir, especially in the summer, the surface water is oversaturated (owing to bio-logical activity) in the vertical direction; at the rogical activity) in the vertical direction; at the same time bottom water at depths of 5 m to 74 m contain less than 4 mg/L of DO. The low DO concentrations are documented by average values of the yearly measurement of vertical layers in both reservoirs. (Sand-PTT) W91-02387

KEY FACTORS IN TASTE AND ODOUR PROBLEMS FOR MUNICIPAL WATER WORKS USING SURFACE WATER SOURCES. Waterloo Univ. (Ontario). Dept. of Civil Engineer-

For primary bibliographic entry see Field 5F. W91-02394

ORGANIC SOLVENT-SOLUBLE CONTENTS OF NICKEL AND COBALT IN SOME ALGAE. Mainz Univ. (Germany, F.R.). Inst. fuer Anorgan-ische Chemie und Analytische Chemie. R. Pfarr, and R. Neeb. Naturwissenschaften NATWAY, Vol. 77, No. 8, p 383-384, August 1990. 1 tab, 5 ref.

Descriptors: \*Algae, \*Chemical analysis, \*Chemical speciation, \*Laboratory methods, \*Nickel, \*Path of pollutants, \*Solvents, Chlorophyta, Cobalt, Germany, Heavy metals, Organic solvents,

Heavy metal speciation studies have gained in-creased importance, especially in view of the need to assess the biological behavior of these metals. Algae samples, mostly Cladophora and Ulothrix, were collected in the Rheinhessen region near Mainz and the total amounts of Ni and Co were mainz and the total amounts of Ni and Co were determined by adsorption voltammetry with demethylglyoxime. The solvent-soluble amounts of Ni and Co were measured for a non-polar solvent (hexane) as well as a weakly polar one (chloroform). About 0.1-1.7% of the total Ni and 0.1-2.0% of the total Co are extracted into the solvents with the fraction of metal soluble in the weakly polar solvent higher than the fraction soluble in the solvent higher than the fraction soluble in the nonpolar solvent. A correlation between the total amount present and that extracted was not found. Treatment of the algae prior to the analytical procedure, e.g., with 0.02 molar EDTA per 1 or 0.1 molar HCIV., decreased the total metal content to a degree which varied from sample to sample, but it did not noticeably influence the fraction of metal which dissolved in the organic solvents. (Hoskin-PTT) W91-02401

USE OF CLUSTER ANALYSIS TO DEFINE PERIODS OF SIMILAR METEOROLOGY AND PRECIPITATION CHEMISTRY IN EASTERN NORTH AMERICA: PART I. TRANSPORT

Michigan Univ., Ann Arbor. Dept. of Atmospheric, Oceanic and Space Sciences.

M. E. Fernau, and P. J. Samson.

Journal of Applied Meteorology JAMOAX, Vol. 29, No. 8, p 735-750, August 1990. 12 fig, 3 tab, 23

Descriptors: \*Acid rain, \*Chemistry of precipita-tion, \*Cluster analysis, \*Meteorology, \*North America, \*Path of pollutants, \*Regional Acid Deposition Model, \*Weather patterns, Climatolo-gy, Computer programs, Model studies, Rainfall distribution, Synoptic analysis, Weather data col-

An aggregation approach is desirable in order to use results from the Regional Acid Deposition

Model to determine seasonal or annual deposition loads in eastern North America. The complexity and number of computations involved in the Regional Acid Deposition Model make it costly to directly model long-term deposition by repeated simulation of episodes of several days duration. Cluster analysis has been used sparingly in synoptic climatological and air pollution applications. Cluster analysis was applied to transport vectors, derived from three years of daily backwards trajectories, in order to define a synoptic climatology of representative three-day periods of air mass movement. The resulting clusters represent groups whose mean air mass transport fields were statistically different from one another and corresponded to the types of high and low pressure patterns seen Model to determine seasonal or annual deposition to the types of high and low pressure patterns seen on daily weather maps. Seasonal differences were evident in the frequency of occurrence of each cluster. The clusters were relatively insensitive to cluster. The clusters were relatively insensitive to changes in number of sites or years used; however, different clustering methods yielded somewhat dif-ferent clusters. Ward's hierarchical grouping method yielded clusters with more or less equal numbers while other methods tended to produce numbers while other methods tended to produce one large cluster and a series of outlier clusters. Cluster analysis was useful in the computer-assisted classification of spatial patterns of weather data and should be considered for use along with more widely used synoptic climatological tools such as principal component analysis. (See also W91-02410) (Mart PTT) principal componen 02410) (Mertz-PTT) W91-02409

USE OF CLUSTER ANALYSIS TO DEFINE PERIODS OF SIMILAR METEOROLOGY AND PRECIPITATION CHEMISTRY IN EASTERN NORTH AMERICA: PART II. PRECIPITATION PATTERNS AND POLLUTION DEPOSITION. PATTERNS AND POLLUTION DEPOSITION. Michigan Univ., Ann Arbor. Dept. of Atmospheric, Oceanic and Space Sciences.
M. E. Fernau, and P. J. Samson.
Journal of Applied Meteorology JAMOAX, Vol.
29, No. 8, p 751-761, August 1990. 8 fig, 5 tab, 19

Descriptors: \*Acid rain, \*Chemistry of precipita-tion, \*Cluster analysis, \*Meteorology, \*North America, \*Path of pollutants, \*Weather patterns, Climatology, Computer models, Deposition, Model studies, Rainfall distribution, Regional Acid Deposition Model, Synoptic analysis, Water pollu-tion sources, Weather data collections.

The spatial precipitation patterns and wet deposi-tion chemistry associated with transport-derived clusters were examined to determine whether representative meteorological events conducive to high acid deposition could be identified. These high acid deposition could be identified. These representative events could be used in aggregation schemes to extend the results of the episode-based Regional Acid Deposition Model to determine seasonal or annual deposition loads in eastern North America. Cluster analysis has been little used in synoptic climatological and air pollution applications to date. Cluster analysis was applied to transport vectors, derived from three years of daily trajectories arriving at monitoring sites, in order to define a synoptic climatology of representative three-day periods of air mass movement. The resulting clusters were successful in defining wet, try, polluted and nonnolluted clusters, as shown dry, polluted and nonpolluted clusters, as shown by the spatial patterns of median deposition and by statistical testing. The highest pollutant depositions over the widest areas resulted from mean transport patterns with large areas of slow air mass move-ment over the regions of high sulfur emissions and ment over the regions of high sulfur emissions and which were frequently persistent over several periods or followed persistent clusters. There was a large amount of overlap among the chemistry distributions and large variation within most of the clusters. Seasonal differences exist within each cluster, with sulfur deposition within a given cluster generally being higher in the warmer months. Cluster analysis was shown to be useful in the computer-assisted classification of spatial patterns of weather and pollution data. (See also W91-02409) (Mertz-PTT)

GROUNDWATER MONITORING: VOLATILE ORGANIC CHEMICALS BENEATH UNSEWERED SUBDIVISION.

Wisconsin Univ.-Eau Claire, Dept. of Geology.

Journal of Environmental Health JEVHAH, Vol. 53, No. 2, p 26-28, September/October 1990. 5 fig.

Descriptors: \*Drinking water, \*Groundwater pol-lution, \*Path of pollutants, \*Public health, \*Vola-tile organic compounds, \*Water pollution sources, Septic wastewater, Tetrachloroethylene, Water quality standards, Well data, Well water, Wiscon-

Water supply wells in Mill Run Subdivision, Eau Claire County, Wisconsin were sampled for vola-tile organic chemicals. Mill Run was selected because on-site septic-tank, soil-absorption systems within the subdivision had increased the nitrate-nitrogen levels in the water supply wells to an average of 11.1 mg/L and volatile organic chemiaverage of 11.1 mg/L and volatile organic chemicals occur in septic system cleaners and other household products. Fifty-nine water samples from 26 water-supply wells in and adjacent to the unsewered subdivision were analyzed. Three samples from two wells had 1.3 to 3.1 micrograms/L of tetrachloroethylene, but the source of the tetrachloroethylene could not be determined from available data. The enforcement standard in Wisconsin for tetrachloroethylene is 1 micrograms/L. The Wisconsin Department of Natural Resources notified in writing the residents of the duplexes served by Wells 21 and 18 of the results of the volatile organic chemicals sampling and the enforcement standard for tetrachloroethylene. Residents were warned not to drink the water. (Mertz-dents were warned not to drink the water. (Mertz-dents were warned not to drink the water. dents were warned not to drink the water. (Mertz-PTT) W91-02413

MERCURY ACCUMULATION IN RELATION TO SIZE AND AGE OF ATLANTIC HERRING (CLUPEA HARENGUS HARENGUS) FROM THE SOUTHWESTERN BAY OF FUNDY,

Guelph Univ. (Ontario). Dept. of Zoology.

B. M. Braune B. M. Braune. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 3, p 311-320, May 1987. 3 fig. 7 tab, 46 ref. Natural Sciences and Engineering Research Council of Canada Strategic Grant No. G0304 (1980-83).

Descriptors: \*Bioaccumulation, \*Canada, \*Fish, \*Herring, \*Mercury, \*Path of pollutants, \*Water pollution effects, Aquatic environment, Bay of Fundy, Chemical analysis, Correlation analysis, Data interpretation, Fate of pollutants, Marine animals, Marine environment, Marine pollution, Metabolism, Model studies, Muscle, Water analysis, Zooplankton.

Relationships between weight, length or age, and total mercury concentration in Atlantic herring were investigated. In addition, the applicability a model for total mercury accumulation developed for freshwater fish to a sampled population of marine fish, specifically Atlantic herring, was also determined. Measured muscle and whole fish total mercury concentrations showed significant positive correlations with age, weight and length, in order of decreasing correlation. Within herring age classes, however, muscle and whole fish mercury concentrations showed significant negative correlations with weight and length due to a growth dilution effect in 1 and 2 year old herring. However, a positive correlations with weight and length er, a positive correlations with weight and length was demonstrated in 3 to 5 year old fish. A bioenergetic-based pollutant accumulation model was used to describe total mercury accumulation for the commercially valuable Atlantic herring aged 3 to 5 years. The predicted values fell within one standard deviation of the measured annual body burdens for the herring. (Author's abstract) W91-02433

TOXICITY OF CHLORINATED BORNANE (TOXAPHENE) RESIDUES ISOLATED FROM GREAT LAKES LAKE TROUT (SALVELINUS NAMAYCUSH).

Michigan State Univ., East Lansing. Pesticide Research Center.

#### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 5B-Sources Of Pollution

For primary bibliographic entry see Field 5C. W91-02435

EFFECTS OF CHLORINATED BENZENES ON DIATOM FATTY ACID COMPOSITION AND QUANTITATIVE MORPHOLOGY: I. 1,2,4-TRICHLOROBENZENE.

Michigan Univ., Ann Arbor. Great Lakes Re-search Div. For primary bibliographic entry see Field 5C. W91-02436

EFFECTS OF CHLORINATED BENZENES ON DIATOM FATTY ACID COMPOSITION AND QUANTITATIVE MORPHOLOGY: II. 1,3,5-TRICHLOROBENZENE.

Michigan Univ., Ann Arbor. Great Lakes Re-

For primary bibliographic entry see Field 5C. W91-02437

EFFECTS OF CHLORINATED BENZENES ON DIATOM FATTY ACID COMPOSITION AND QUANTITATIVE MORPHOLOGY: III. 1,2,3-TRICHLOROBENZENE.

Michigan Univ., Ann Arbor. Great Lakes. Re-

For primary bibliographic entry see Field 5C. W91-02438

EFFECTS OF CHLORINATED BENZENES ON DIATOM FATTY ACID COMPOSITION AND QUANTITATIVE MORPHOLOGY: IV. PENTACHLOROBENZENE AND COMPARISON WITH TRICHLOROBENZENE ISOMERS. Michigan Univ., Ann Arbor. Great Lakes Re-

For primary bibliographic entry see Field 5C. W91-02439

DDT CONTAMINATION OF BENTHIC MA-CROINVERTEBRATES AND SEDIMENTS FROM TRIBUTARIES OF WHEELER RESER-VOIR, ALABAMA.

Auburn Univ., AL. Dept. of Fisheries and Allied

Auburn Univ., AL. Dept. of Patients and Allace Aquacultures. E. C. Webber, D. R. Bayne, and W. C. Seesock. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 5, p 728-733, September 1989. 1 fig. 4 tab, 18 ref.

Descriptors: \*Alabama, \*Benthic environment, \*Benthic fauna, \*Bottom sediments, \*DDT, \*Food chains, \*Macroinvertebrates, \*Path of pollutants, \*Reservoirs, \*Sediment analysis, \*Sediment contamination, \*Streams, Benthos, Bottom sampling, Ecosystems, Trophic level, Water pollution

Residues of 1,1,1-trichloro-2,2-bis(p-chlorophenyl) ethane (DDT) were measured quarterly during 1983-1984 in bottom sediments and benthic ma-1883-1984 in bottom sediments and benthic macroinvertebrates from heavily contaminated sections of Huntsville Spring Branch (HSB) and Indian Creek (IC), backwater streams on Wheeler Reservoir (Alabama). Bottom muds from both channel and overbank locations contained mean concentrations of DDTR (DDT and its metabolites) ranging from 12 to 2,730 ppm (dry weight). Sediment DDTR were highest in HSB at stations closest to the original DDT source. Stations in IC, downstream from HSB, had progressively lower DDTR as distance from the DDT source increased. Macroinvertebrate DDTR measured from several stations suggested bioaccumulation of residues mainly through food webs. However, at the most contaminated locations, substrate and mode of life appeared to override trophic level effects in most contaminated locations, substrate and mode of life appeared to override trophic level effects in determining DDTR in the benthos. There is apparently an upper limit to the amount of DDTR these organisms usually accumulate. For example, detritivore DDTR from channel sediments at two stations just downstream from the DDT source averaged 2,370 ppm and 96 ppm, respectively. Benthic macroinvertebrates in the highly contaminated sediments of HSB and IC apparently acquire DDTR from water, sediments, and food. (Author's abstract)

W91-02442

SEASONAL DELIVERY OF THE PARTICU-LATE FORMS OF PHOSPHORUS TO LAKE GENEVA FROM THE UPPER RHONE RIVER. Geneva Univ. (Switzerland). Inst. F.-A. Forel. For primary bibliographic entry see Field 2H. W91-02448

PERSISTENCE OF DDT IN THE YAKIMA RIVER DRAINAGE, WASHINGTON. Washington State Dept. of Ecology, Olympia. A. Johnson, D. Norton, and B. Yake. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 3, p 289-297, May 1988. 3 fig. 4 tab, 34 ref.

Descriptors: \*DDD, \*DDE, \*DDT, \*Fate of pol-lutants, \*Fish, \*Nonpoint pollution sources, \*Path of pollutants, \*Pesticide residues, \*River sedi-ments, Environmental quality, Halogenated pesti-cides, Pollutant identification, Seasonal variation, Washington, Water pollution, Yakima River.

DDT compounds (p,p' and o,p' isomers of DDT and metabnolites DDE and DDD were studied in fish, water, and bed sediments from the Yakima River drainage in Washington State. p,p'-DDE was the predominant compound in fish and the only DDT compound detected in water from the main stem of the river. However, concentrations of port. DDT predominated in water and bed sediments. p,p'-DDT predominated in water and bed sedi-ments from Yakima tributaries identified as current sources of DDT compounds. These data suggest sources of DDT compounds. These data suggest DDT is extremely persistent in Yakima basin soils. Data compiled by the U.S Geological Survey and U.S. Fish and Wildlife Service illustrated a historical trend toward decreasing concentrations of DDT compounds in water and fish from the main stem of the Yakima River. A positive correlation between the surface of the sur between runoff and water concentrations of chlor-inated pesticides has been demonstrated in a number of investigations. Results from this study showed DDT compounds were routinely detecta-ble in several Yakima River tributaries during the irrigation season, but could not be detected in any tributary after diversions for irrigation ceased. (Mett.-PTT) W91-02457

EFFECT OF URANIUM MINE TAILINGS ON RADIONUCLIDE CONCENTRATIONS IN LANGLEY BAY, SASKATCHEWAN, CANADA. Environmental Protection Service, Regina (Sas-

Environmental Frotection Section, August Matchewan).
D. T. Waite, S. R. Joshi, and H. Sommerstad.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 3, p 373-380, May 1988. 1 fig. 5 tab, 28 ref.

Descriptors: \*Lake Athabasca, \*Mine wastes, \*Path of pollutants, \*Radioisotopes, \*Uranium radioisotopes, \*Water pollution sources, Acid mie drainage, Bioaccumulation, Calcium, Canada, Conductivity, Ions, Langley Bay, Magnesium, Sulfates, Water chemistry, Water pollution.

From 1955 to 1964 the Gunnar Uranium Mine (Canada) produced approximately 8000 tons of uranium oxide and about 5,000,000 tons of waste uranium oxide and about 5,000,000 tons of waste rock tailings. Large quantities of fine tailings material washed into Langley Bay, a shallow bay opening onto Lake Athabasca. The initial movement of tailings into Langley Bay occurred suddenly, as a result of the demolition of a retaining dam. This material consisted of a slurry of untreated, acidic wastes produced by the sulfuric acid extraction process used by the mine. Following this initial event, effluent from the process continued to transport materials in the have until mine closure in 1960. port materials in the bay until mine closure in 1964. Runoff from the uphill tailings continues to move various metals into Langley Bay. The sediment data showed concentrations of radionuclides and data showed concentrations of radioniciness and some heavy metals to be much higher in Langley Bay than in the uncontaminated control area. The tailings content of the sediments in Langley Bay had significantly affected the water chemistry. The water of the two control sites was of low conductivity, Ca(2+), HCO3(-) type, typical of shield areas. Sites overlying tailings showed marked dif-

ferences in both major and minor components. ferences in both major and minor components. Conductivities were higher as a result of increases in Ca(2+), Mg(2+) and SO4(2-), probably derived from the CaSO4 and MgSO4 precipitates reported to be in the tailings. Concentrations of uranium found in Langley Bay water fell within the 0.5-200 microgram/L range reported for American rivers. Concentrations of 226Ra and 210Pb at some sites were higher than those reported for other northern Canadian waters above contaminated sediments.

These radionuclides were available for uptake by
the resident biota. The northern pike and whitefish
populations of Langley Bay contained higher body
burdens of radionuclides than those from uncontaminated control areas. (Mertz-PTT) W91-02460

TOXICITY TESTING OF SUBLETHAL EFFECTS OF DREDGED MATERIALS. Old Dominion Univ., Norfolk, VA. Applied Marine Research Lab.

For primary bibliographic entry see Field 5C. W01\_02461

INORGANIC POLLUTION OF THE MAN-MADE LAKES OF WADI EL-RAIYAN AND ITS IMPACT ON AQUACULTURE AND WILDLIFE OF THE SURROUNDING EGYPTIAN

DESERI.

Cairo Univ., Giza (Egypt). Faculty of Agriculture.

M. A. Saleh, M. A. Saleh, M. M. Fouda, M. A.

Saleh, and M. S. A. Abdel Lattif.

Archives of Environmental Contamination and

Toxicology AECTCV, Vol. 17, No. 3, p 391-403,

May 1988. 4 fig. 8 tab, 45 ref.

Descriptors: \*Aquaculture, \*Deserts, \*Reservoirs, \*Water pollution effects, \*Water pollution sources, Agricultural runoff, Ammonia, Bioaccumulation, Cadmium, Carbonates, Copper, Cyanide, Egypt, Halogens, Heavy metals, Iron, Lead, Manganese, Mercury, Nitrates, Nitrites, Phosphates, Selenium, Silicates, Sulfates, Sulfites, Thiocyanate, Water

El-Raiyan lakes were created as a reservoir for agricultural drainage wastewater in the Western Desert of Egypt. The project was started in 1968 and has been operating since 1973. Physical and chemical properties of water from 17 sampling stations in the lakes and in the springs of the surrounding deserts were monitored every three months during the years 1984 and 1985. Concentrations of metals (cadmium, copper, iron, lead, manganese, mercury, selenium, and zinc) and or inorganic anions (sulfate, sulfite, sulfide, nitrate, nitrite, ammonia, cyanide, thiocyanate, halogens, carbonate, silicate, and phosphate) were generally lower than those reported for other lakes of Egypt which are used as wastewater reservoirs. The conlower than those reported for other lakes of Egypt which are used as wastewater reservoirs. The concentrations of metals and inorganic anions in water varied according to the distance from the origin of the lakes, depth, and seasons of the year. Concentrations of heavy metals in fish and in selected wildlife fauna and flora of the surrounding deserts were also determined. Animals living near the lakes had much higher concentration of heavy metals, particularly lead, mercury, and cadmium, than animals of the same species collected further away from the lakes. High rate of evaporation may cause concentrations of heavy metals to soon reach dangerous levels. This may effect the utilization of the lake for fish production and may also pollute dangerous levels. Inis may errect the utilization or the lake for fish production and may also pollute groundwater of the nearby springs and be trans-ferred through the food chain to wildlife of the area. The use of biological filters and/or growing grass on the sand dunes may be used to clean up heavy metals from the water. (Mertz-PTT) W91-02462

TIGRIS-EUPHRATES DELTA: A MAJOR SOURCE OF PESTICIDES TO THE SHATT ALARAB RIVER (IRAQ).

Basrah Univ. (Iraq). Dept. of Environmental Marine Chemistry. A. A. DouAbul, H. T. Al-Saad, A. A. Al-Timari, and H. N. Al-Rekabi.

#### Sources Of Pollution-Group 5B

May 1988. 4 fig, 5 tab, 33 ref.

Descriptors: \*Bioaccumulation, \*Chlordane, \*DDD, \*DDE, \*DDT, \*Deltas, \*Endrin, \*Halogenated pesticides, \*Heptachlor, \*Path of pollutants, \*Shatt Al-Arab River, \*Water pollution sources, Arid lands, Euphrates River, Iraq, Mussels, Pesticider residues, Pesticides, River sediments, Tigris River, Water pollution.

Organochlorine pesticides were determined in the Tigris-Euphrates-Shatt al-Arab Delta by high resolution gas chromatography. Mean concentrations of pesticides in the dissolved form were 98 ng/L p,P-DDE (2,2-bis(p-chlorophenyl)-1,1-dichloroethylene); 8 ng/L o,p-DDD (2,2-bis(p-chlorophenyl)-1,1-dichloroethane); 28 ng/L aldrin; 66 ng/L p,P-DDT (2,2-bis(p-chlorophenyl)-1,1-lrichloroethane); 30 mg/L aldrin; 66 ng/L dieldrin; 57 ng/L cis-chlordane; 15 ng/L trans-chlordane and 10 ng/L heptachlor. Mean particulate concentrations were 76 microgram/kg py-DDT; 154 microgram/kg porton peram/kg endrin; 11 microgram/kg cis-chlordane; and 68 microgram/kg heptachlor. Partitioning of dissolved pesticides was evident along the Shatt al-Arab River, which was reflected by significantly and to microgram/kg includes to the horizontal dissolved pesticides was evident along the Shatt al-Arab River, which was reflected by significantly higher levels of particulate species down river. Residues of p,p'-DDE; p,p'-DDD; p,p'-DDT; endrin and dieldrin were confirmed in sediments from this river; however, DDD was confined to the anoxic sub-surface layers only. Absorbing pesticides from both water and suspended particulate matter, Shatt al-Arab mussels had mean residue concentrations of 43 microgram/kg dirit; 24 microgram/kg dieldrin; 6 microgram/kg dirit; 24 microgram/kg trans-chlordane. The euphrates River was the major source of pesticides in the dissolved form, while the Tigris River contributed pesticides mainly in the particulate form to the Shatt al-Arab River. The sediment of this river was the largest reservoir of organochlorine pesticides, where more than 80% of the studied conwas the largest reservoir of organic morne pesitionides, where more than 80% of the studied contaminants reside. (Author's abstract)
W91-02463

LONG-TERM MONITORING OF POLYCHLO-RINATED BIPHENYLS IN THE HUDSON RIVER (NEW YORK) USING CADDISFLY LARVAE AND OTHER MACROINVERTE-

BRATES. New York State Dept. of Environmental Conservation, Albany. Div. of Water. M. A. Novak, A. A. Reilly, and S. J. Jackling. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 6, p 699-710, November 1988. 6 fig. 5 tab, 11 ref.

Descriptors: \*Bioassay, \*Bioindicators, \*Hudson River, \*Monitoring, \*Polychlorinated biphenyls, \*Water pollution sources, Caddisflies, New York, Water pollution.

Polychlorinated biphenyl (PCB) contamination of the Hudson River occurred over a period of nearly 30 years, via discharges by capacitor manufactur-ing plants in Hudson Falls and Fort Edward, New York. Concentrations of PCBs in the Hudson River were monitored from 1978 through 1985, by chromatographic analysis of the tissue residues of chromatographic analysis of the tissue residues of hydropsychid caddisflies and the contents of artifi-cial substrate samplers. For both means of assesshydropsychid caddisflies and the contents of artifi-cial substrate samplers. For both means of assess-ment, levels of Aroclor 1016 and Aroclor 1254 were positively correlated. Temporally, PCB con-centrations decreased at all sampling stations from 1978 to 1980, but increased and remained stable from 1981 through 1985. Spatially, PCB levels as measured by artificial substrate samplers, de-creased along the length of the river. Spatial trends in caddisflies were not as consistent as those of the artificial substrate samplers; in 6 of the 8 years sampled, there was no significant decrease in PCB concentrations in caddisflies from the point of dis-charge of the contaminant to the most downstream concentrations in caudisines from the point of dis-charge of the contaminant to the most downstream sampling site. (Mertz-PTT) W91-02464

POLYCHLORINATED BIPHENYL CON-GENERS IN SEDIMENTS, PLANKTON, MOL-LUSCS, CRUSTACEANS, AND EEL IN A

FRESHWATER LAKE: IMPLICATIONS OF USING REFERENCE CHEMICALS AND INDI-CATOR ORGANISMS IN BIOACCUMULA-TION STUDIES

TION STUDIES.
Amsterdam City Environmental Health Research Lab. (Netherlands).
R. van der Oost, H. Heida, and A. Opperhuizen.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 6, p 721-729, November 1988. 3 fig. 5 tab, 36 ref.

Descriptors: \*Bioaccumulation, \*Biological magnification, \*Food chains, \*Monitoring, \*Path of polutants, \*Polychlorinated biphenyls, Fish, Lakes, Macroinvertebrates, Plankton, The Netherlands, Water pollution.

The concentrations of six polychlorinated biphenyl The concentrations of six polychlorinated biphenyl (PCB) congeners in sediments and four classes of biota species of the aquatic food chain were investigated in a freshwater lake near Amsterdam, The Netherlands. Despite the low concentrations of the contaminants in the sediment, significant amounts of PCBs were found in plankton, macro-inverterates and fish. The composition of the PCB mixtures found in the various organisms cannot be explained in terms of simple partitioning of the PCB congeners between sediment, water, and organisms. In addition to bioconcentrations, it is likely that biomagnification via consumption of ganisms. In addition to bioconcentrations, in likely that biomagnification via consumption of contaminated food also contributed significantly to the total PCB concentrations. This is most pro-nounced for the higher trophic food-chain organisms. Studying bioaccumulation processes monitoring just one type of organism is proba monitoring just one type or organism is probably not very suitable, due to the pronounced differences in accumulation patterns demonstrated for the different organisms. In addition, significant differences were found in the accumulation of the six PCBs in the various biotic samples. This indicates that the fate of the individual consequence and the state for the individual consequence and these states of the individual consequences. by the fate of the individual congeners and there-fore cannot be monitored in terms of total PCBs concentrations. (Author's abstract) W91-02465

SPATIAL DIFFERENCES AND TEMPORAL TRENDS OF ORGANOCHLORINE COM-POUNDS IN BIOTA FROM THE NORTH-WESTERN HEMISPHERE.

Statens Livsmedelsverk, Uppsala (Sweden). Food Research Dept.
O. Andersson, C. E. Linder, M. Olsson, L.

O. Andersson, L. E. Linder, M. Oisson, L. Reutergardh, and U. B. Uvemo. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 6, p 755-765, November 1988. 4 fig. 3 tab, 37 ref.

Descriptors: \*Biological magnification, \*DDD, \*DDE, \*DDT, \*Halogenated pesticides, \*Path of pollutants, \*Pesticide residues, \*Polychlorinated biphenyls, \*Spatial distribution, \*Temporal distribution, Animals, Arctic zone, Baltic region, Birds, Chlordane, Fate of pollutants, Fish, Polychlorinated complement. Seals

Tissues of animal species from various trophic Tissues of animal species from various trophic levels in the northwestern hemisphere were collected and analyzed for the presence of polychlorinated camphenes (PCC, for example toxaphene) DDT and its metabolites DDD and DDE and PCB (polychlorinated biphenyl) to elucidate differences in geographical distribution, biomagnification and temporal trends. Many of the samples were also analyzed for the presence of chlordane. The previously achieved knowledge of DDT and PCB contamination was used as a yardstick for characterizing the exposure regime of the other reanochlorine compounds. No pronounced geoorganochlorine compounds. No pronounced geo-graphical differences were found for polychlori-nated camphenes when comparing animals from graphical differences were found for polychlori-nated camphenes when comparing animals from the Arctic region with corresponding species in the Baltic, while PCB, DDD and DDE showed definite spatial differences. The highest concentra-tions of DDD, DDE and PCB were found in fish predators, such as raptorial birds and seals, from the Baltic. Polychlorinated camphenes levels in fish exceeded levels of DDD, DDE and PCB in the North Atlantic and the polychlorinated camthe North Atlantic and the polychlorinated cam-phenes levels in Swedish fish were as high or higher than the DDD and DDE levels. While the DDD, DDE, and PCB levels for all trophic levels

ranged from 0.14-990 mg/Kg fat, the corresponding range for polychlorinated camphenes was only 0.33-17 mg/kg. This indicated less biomagnification of polychlorinated camphenes and/or a more effective metabolism of polychlorinated camphenes, compared with DDD, DDE, and PCB, at high trophic levels. The levels of DDD, DDE, and PCB is Sueviels fish and birds above. PCB is Swedish fish and birds showed a decrease during the late seventies and the beginning of the eighties. For the polychlorinated camphene levels, however, no distinct trends could be discerned during the same period in any of the areas studied.
(Author's abstract)
W91-02467

EVALUATING THE IMPACT OF MUNICIPAL WATER FLUORIDATION ON THE AQUATIC ENVIRONMENT.

Lakeshore General Hospital, Pointe Claire (Quebec). Community Health Dept. For primary bibliographic entry see Field 5C. W91-02510

DIFFUSION AND DISPERSION IN COASTAL

California Inst. of Tech., Pasadena. Dept. of Envi-ronmental Engineering Science. E. J. List, G. Gartrell, and C. D. Winant. Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 10, p 1158-1179, October 1990. 17 fig. 1 tab, 15 ref.

Descriptors: \*Coastal waters, \*Diffusion, \*Dispersion, \*Ocean dumping, \*Path of pollutants, \*Water currents, California, Eddy diffusion, Oceanography, Outfall, Theoretical analysis, Tides, Turbulent flow, Waste disposal.

Oceanographic drogue and current meter studies were performed in the coastal waters of southern California. The transport and dispersing properties of the oceanographic currents were evaluated over diurnal periods and related to extant theories of diffusion and dispersion in coastal waters. The measurements provided useful results concerning Lagrangian and Eulerian estimates of turbulent diffusivity. In particular, they show the importance of regarding diffusivity as an ensemble average property of the turbulent flow field, and that great care is necessary in applying the concept to single realization studies. It was shown that under some tide conditions significant negative diffusivities are possible. Furthermore, coastal motions at this location were very coherent up to scales of 4-5 km, at which point they become rapidly dispersive. The results provide information of value in the design of ocean disposal systems. (Author's abstract) W91-02521

ESTIMATION OF FLOW THROUGH AND OVER ARMORED SLOPES.

Nuclear Regulatory Commission, Washington, DC. Div. of Waste Management.

For primary bibliographic entry see Field 5E. W91-02526

FREE AMMONIA AND TOXICITY CRITERIA IN A POLLUTED URBAN LAKE. Upstate Freshwater Inst., Inc., Syracuse, NY. S. W. Effler, C. M. Brooks, M. T. Auer, and S. M.

Research Journal of the Water Pollution Control Federation JWPFA5, Vol. 62, No. 6, p 771-779, September/October 1990. 7 fig, 3 tab, 40 ref.

Descriptors: \*Ammonia, \*Eutrophication, \*Lake restoration, \*Path of pollutants, \*Urban areas, \*Water pollution control, \*Water quality, Algal growth, Hydrogen ion concentration, Monitoring, New York, Onondaga Lake, Seasonal variation, Toxicity, Wastewater pollution.

The distribution of free ammonia in Onondaga Lake, New York, a polluted urban lake, was documented for the spring-to-fall interval of 1988. Free ammonia levels were compared with national criteria set to protect fish from toxic effects. Nearly continuous contravention of the national chronic

#### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

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toxicity criteria for free ammonia for salmonid and nonsalmonid fish, at all depths, and infrequent connonsalmonid fish, at all depths, and infrequent contravention of the national acute toxicity criterion for nonsalmonids in the upper waters was documented. The occurrence of particularly high concentrations of free ammonia was associated with increases in pH, driven by high levels of algal growth. A major reduction (> 60%) in the concentration of total ammonia in the epilimnion of the lake is necessary to remediate the lake's free ammonia problem. This would require a major reduction (> 50%) in the load presently received from the adjoining wastewater treatment plant. This remediation effort should be integrated with ongoing programs, focusing on the lake's problem of excessive algal growth, because of the impact of algal photosynthetic activity on levels of free and total ammonia in the lake. (Author's abstract)

TOTAL TRIHALOMETHANE FORMATION DURING TARGETED AND CONVENTIONAL CHLORINATION OF SEAWATER FOR BIO-

FOULING CONTROL.
For primary bibliographic entry see Field 5F.
W91-02538

SUPERCOMPUTERS AND THEIR USE IN MODELING SUBSURFACE SOLUTE TRANS-PORT. Western Australia Univ., Nedlands. Centre for

Water Research.
For primary bibliographic entry see Field 7C.
W91-02543

REVISION OF THE SAPROBIC SYSTEM (EINE REVISION DES SAPROBIENSYSTEMS), Landesamt fuer Wasser und Abfall Nordrhein Westfalen, Duesseldorf (Germany, F.R.). For primary bibliographic entry see Field 5G. W91-02546

THIORENCARR S-OXYGENATION OF S-OXYGENATION OF THIOBENCARB (BOLERO) IN HEPATIC PREPARATIONS FROM STRIPED BASS (MORONE SAXATILIS) AND MAMMALIAN SYSTEMS.

California Univ., San Francisco, School of Phar-

macy. For primary bibliographic entry see Field 5C.

NUTRIENTS, HEAVY METALS AND ORGANIC MICROPOLLUTANTS IN AN EUTROPHIC BRAZILIAN LAGOON.

Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.

B. A. Knoppers, L. D. Lacerda, and S. R.

Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 8, p 381-384, August 1990. 5 tab, 30 ref.

Descriptors: \*Brazil, \*Coastal lagoons, \*Effluents, \*Eutrophic lakes, \*Eutrophication, \*Heavy metals, \*Nutrients, \*Organic pollutants, \*Urbanization, \*Water quality, Environmental quality, Path of pollutants, Sediment contamination, Trace metals, Water pollution, Water sampling.

The Fluminense coastline between the cities of Rio de Janeiro and Cabo Frio includes numerous eutrophic lagoons. A recent increase in urbanization has resulted in uncontrolled effluent discharges into some of these lagoons. An evaluation was made of the environmental quality with respect to nutrients, heavy metals, and organic micropollutants at Lagoa de Guarapina, a tropical eutrophic lagoon of Rio de Janeiro State, Brazil. Sampling for dissolved inorganic nitrogen species was conducted over an annual cycle (winter 1985 to 1986) at four stations in the lagoon. In addition, samples for particulate organic carbon and nitrogen were colparticulate organic carbon and nitrogen were col-lected at the central station in the lagoon. Trace metal analyses were performed on surficial sedi-ments at five stations and their vertical distribution ments at the stations and the terms was assessed on a separate sediment core from the central lagoon station. The cations exchange capacity, organic matter content and heavy metals manganese, chromium, zinc and lead generally de-

crease from the fluvial to the lower estuarine sta-tion, with maximum values at the central lagoon station and decrease sharply towards the lower portion, close to the tidal inlet. Nickel and copper, however, remained fairly constant. Concentrations nowever, remained tarry constant. Concentrations of nutrients and heavy metals in the lagoon and its tributaries were low, closely resembling natural conditions. However, lead formed the exception, and its presence in conjunction with detectable anu its presence in conjunction with detectable concentrations of organic micropollutants suggest that minor pollution effects are occurring via atmospheric inputs. (VerNooy-PTT)
W91-02555

PERSISTENCE OF SPILLED CRUDE OIL IN A TROPICAL INTERTIDAL ENVIRONMENT.
Puerto Rico Univ., Mayaguez. Dept. of Marine

J. E. Corredor, J. M. Morell, and C. E. Del

Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 8, p 385-388, August 1990. 2 fig, 2 tab, 15 ref.

Descriptors: \*Degradation, \*Fate of pollutants, \*Mangrove swamps, \*Marine pollution, \*Oil spills, \*Path of pollutants, \*Puerto Rico, \*Sediment contamination, Biodegradation, Hydrocarbons, Intertidal areas, Oil, Oil pollution, Sediment analysis,

In the last few decades, two major tanker spills of crude oil have occurred off the southern coast of Puerto Rico; that of the Argea Prima in 1962 and the Zoe Colocotronis in 1977. As a contribution to the Zoe Colocorons in 1977. As a contribution to the CARIPOL program for petroleum pollution research and monitoring in the Caribbean region, the vertical distribution of hydrocarbons in a core from sediments was documented. Intertidal sedi-ments at Bahia Sucia, on the southwest coast of ments at Bahia Sucia, on the southwest coast of Puerto Rico contain discreet subsurface layers of petrogenic hydrocarbons. The uppermost of thes layers contains petroleum contaminants in concen-trations above 100 mg/g and is most probably attributable to the 1977 spill. A deeper layer con-taining a less concentrated load of petroleum hydrocarbons may correspond to the spill of 1962. Sediments above, between and below these two Sediments above, between and below these two layers present low concentrations of typically biogenic hydrocarbons. Although petroleum released to the sea in tropical environments generally suffers rapid degradation, petroleum contaminants reaching intertidal sediments may exhibit long-term persistence. In the case of mangrove-lined intertidal environments, rapid burial coupled to the well-documented bacteriostatic nature of mangrove tannins result in a dramatic decrease in degradation, rates of netroleum bydrocarbons in these radation rates of petroleum hydrocarbons in these environments. Persistence of these substances may environments. Persistence of these substances may well have subsequent long-term deleterious effects upon the mangroves themselves as well as the complex plant and animal communities associated with the mangroves. (VerNooy-PTT) W91-02556

TRACE METALS IN THE SEVERN ESTUARY:

RACE MELIAS IN THE SEVERN ESTUARY: A REAPPRAISAL. Water Research Centre, Medmenham (England). S. C. Apte, J. M. Gardner, A. M. Gunn, J. E. Ravenscroft, and J. Vale. Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 8, p 393-396, August 1990. 2 fig, 2 tab, 10 ref.

Descriptors: \*England, \*Estuarine environment, \*Heavy metals, \*Path of pollutants, \*Trace metals, \*Water pollution sources, Arsenic, Cadmium, Chromium, Copper, Distribution patterns, Lead, Nickel, Salinity, Severn River Estuary, Water

The Severn estuary is the largest estuary in the United Kingdom. The salinity/concentration profiles of seven dissolved trace metals, i.e., copper (Cu), nicke (Ni), cadmium (Cd), lead (Pb), chromium (Cr), zinc (Zn), and arsenic (As), in the Severn estuary were reported. The metal concentrations observed in this study were considerably lower than those reported in previous work. Despite known inputs of metals through industrial and waste discharges, river inputs play an important part in the estuarine profiles. For Cu, Ni and Zn, riverine inputs appear to be the main source of

metals. The profiles of Cd, Cr and As appear to be dominated by point source discharges in mid-estu-ary. Lateral heterogeneity is small, except in the vicinity of industrial outfalls. In spite of this, quite large between-day variations in dissolved metal large between-day variations in dissolved metal concentrations were observed in the upper estuary. Chromium was the only metal not showing between-day variability. Saline end member concentrations were consistent with ranges quoted for the European coastal shelf area. This survey suggests that atmospheric deposition is far less important, at least as a contributor to concentrations of dissolved metal, though its influence on particulate metal may still be significant. (VerNooy-PTT)

HYDROCARBON CONCENTRATIONS IN SEDIMENTS AND ANIMAL TISSUES FROM THE COASTAL WATERS OF KARACHI.

Karachi Univ. (Pakistan). Inst. of Marine Biology.

Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 8, p 397-399, August 1990. 2 fig. 1 tab, 9 ref.

Descriptors: \*Coastal waters, \*Marine pollution, \*Oil pollution, \*Pakistan, \*Path of pollutants, \*Water quality, Fish, Hydrocarbons, Oil, Oil refineries, Oil spills, Oysters, Sediment analysis, Sediment contamination, Tissue analysis.

Preliminary data is presented on the present levels of petroleum hydrocarbon contamination in coastal waters of Karachi (Pakistan) resulting from the exploitation, refining and routine handling of petroleum. Surface sediment samples in triplicate and subtidal samples were collected from the intertidal zone during low tide from Korangi Creek and Hawks Bay and from Manora Channel. Oysters Hawks Bay and from Manora Channel. Oysters (Crassostrea rivularis and Perna viridis) and fish (Mugil sp. and Acanthopagurus sp.) were also collected. Extracted aliphatic hydrocarbons were analyzed by gas chromatography. In marine sediments a range of hydrocarbons (n-C7 to n-C19) were detected. Levels found in the sediments were 0.03 to 0.16 ng/g for n-C19 and 0 to 0.24 ng/g for n-C16. Hydrocarbon peaks were not observed in the tissues of Perna viridis and fish from any locality. The coastal waters of Karachi seem to discourage persistence of oil pollution due to the availability of light, temperatures characteristic of tropical of light, temperatures characteristic of tropical areas, and well oxygenated water. (VerNooy-PTT) W91\_02558

OIL POLLUTION IN THE SOUTHERN ARABI-AN GULF AND GULF OF OMAN. Institute of Oceanography and Fisheries, Alexan-

dria (Egypt). H. I. Emara

Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 8, p 399-401, August 1990. 6 fig, 2 tab, 11 ref.

Descriptors: \*Arabian Gulf, \*Data collections, \*Marine pollution, \*Oil pollution, \*Water quality, \*Water sampling, Distribution patterns, Hydrocarbons, Oil, Oil spills, Path of pollutants.

Results are presented from the winter cruise (15 February to 3 March, 1987) carried out in the southern Arabian (Persian) Gulf and the gulf of Oman, as well as previous work in the Northwestern Arabian Gulf in 1984 to 1986. Surface and subsurface (10 to 200 m) samples were taken. Kuwait crude oil was used as standard with detection limits of I microgram/L. Petroleum hydrocarbons in surface water varied from 4.6 to 25.2 micrograms/L in the southern Arabian Gulf compared with 4.4 to 63 micrograms/L in the Gulf of pared with 4.4 to 63 micrograms/L in the Gulf of Oman. 54% of the analyzed samples contained less Oman. 34% of the analyzed samples command tess than 16 micrograms/L. Starting from the Qatari waters, the petroleum levels generally showed a decrease in an eastward direction until Sharga in the United Arab Emirates water. The vertical profile of petroleum hydrocarbons was nearly homo-geneous due to vertical mixing characteristic of the winter season. Data from 1984 to 1987 were examwinter season. Data from 1944 to 1947 were examined. Excluding the highly polluted stations, the 1987 levels of petroleum hydrocarbons are not exceptionally high in comparison with other areas in the world oceans. When the concentrations of all stations including the highly contaminated ones

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were considered, the mean values decrease from 1984 to 1987 indicating that during 1984 to 1985 the Gulf water was affected by oil spills due to the Iraq-Iran war. The average concentration of petro-leum hydrocarbons in the Gulf area varied from 15 teum hydrocaroons in the Curi area varied from 15 to 65.2 micrograms/L during the years 1987 and 1984, respectively. The annual contribution of petroleum hydrocarbons that fluxed from the Arabian Gulf to the Gulf of Oman during 2987 is 23% of the annual fluxes recorded in 1984. (VerNooy-PTT) W91-02559

FUCUS VESICULOSUS AS AN INDICATOR OF HEAVY METAL AVAILABILITY IN A FISH FARM RECIPIENT IN THE NORTHERN

FARM RECIPIENT IN THE NORTHERN BALTIC SEA.
Abo Akademi, Turku (Finland). Dept. of Biology. For primary bibliographic entry see Field 5A.
W91-0256

TOXIC-SUBSTANCE CONTROL FOR THE OHIO RIVER.
Ohio River Valley Water Sanitation Commission.

Cincinnati. For primary bibliographic entry see Field 5G. W91-02564

LOADING OF WATER AND SOIL BY POL-LUTANTS IN SHELBY COUNTY. Christian Brothers Univ., Memphis, TN.

Journal of the Tennessee Academy of Science JTASAG, Vol. 65, No. 4, p 121-128, 1990. 2 fig, 7

Descriptors: \*Path of pollutants, \*Pesticides, \*Pollutant load, \*Soil contamination, \*Water pollution sources, Air pollution, Aldrin, Atrazine, Bacteria, DDT, Heptachlor, Herbicides, Memphis, Organic compounds, Pollutant identification, Shelby County, Surface runoff, Suspended solids, Tennessee, Wet deposition.

A study was undertaken to indicate the possible extent of pollution of the surface soil in and near extent of pollution of the surrace soil in and near Memphis. Since rain carries surface and atmos-pheric pollutants into the runoff, water samples were collected and analyzed for pollutants at dif-ferent times during and between rainfall events. Only one site was studied in a residential area and only one site was studied near a chemical plant, to only one site was studied near a chemical plant, to give an idea of the extent of pollution under differing environmental conditions. The results presented are site specific and vary with other factors such as weather, rainfall rate, rainfall intensity, previous rainfall conditions, and number of household pets in the neighborhood. For the residential site, the amounts of various chemicals present were sue, the amounts of various chemicals present were below the surface water criteria for pesticides in public water supplies. Results obtained in the in-dustrial site are also site specific since the extent of pollution mainly depends on the proximity of the study site from the chemical industries. (Lantz-PTT) W91-02583

QUANTITATIVE ASSESSMENT OF THE SOURCES AND GENERAL DYNAMICS OF TRACE METALS IN A SOFT-WATER LAKE. Lancaster Univ. (England). Inst. of Environmental

Lancaster Univ. (England). Inst. of Environmental and Biological Sciences.

J. Hamilton-Taylor, and M. Willis.
Limnology and Oceanography LIOCAH, Vol. 35, No. 4, p 840-851, June 1990. 1 fig. 9 tab, 39 ref.
Natural Environmental Research Council Grant

Descriptors: \*Chemical analysis, \*Heavy metals, \*Lakes, \*Path of pollutants, \*Trace metals, \*Water pollution, Aluminum, Copper, England, Iron, Lead, Manganese, Pollution load, Wastewater disposal, Wet deposition, Windermer, Zinc.

Dissolved (<0.45 microm) and particulate concentrations of Fe, Mn, Al, Cu, Pb, and Zn were measured at intervals of 2-6 weeks in rivers, sewage effluents, atmospheric deposition, and sur-

face lake waters within the Windermere (U.K.) catchment, over a two year period. Factor analysis revealed a number of geochemical associations: a large proportion of the particulate Fe, Al, Pb, and Cu appears to be associated with detrital minerals and organic materials in the rivers, sewage effluents, and atmospheric deposition; redox processes, probably occurring higher in the catchment, have an appreciable influence on the riverine concentrations of dissolved Fe and Mn, particulate Mn, and to a lesser extent particulate Fe and Zn; pollution terms account for most of the variance of dissolved Fe, Cu, Pb, and Zn, and particulate Cu, Pb, and Zn in the sewage effluent and atmospheric deposition data sets; and an association in the rivers of dissolved Al and Zn concentrations with disface lake waters within the Windermere (U.K.) of dissolved Al and Zn concentrations with dis-charge is probably related to catchment soil proc-esses. Mass balances were determined for the metals, including a detailed assessment of the metals, including a detailed assessment of the errors involved. An imbalance was apparent between the inputs and the outputs (flushing and sedimentation), probably due to the underestimation of particulate loads in the rivers. Fe, Mn, and Al were predominantly (> 90%) supplied by rivers, while Cu, Pb, and Zn received significant inputs from direct atmospheric deposition and sewage discharges. The residence times of the dissolved metals in Windermere were in the order: Cu > Zn > Pb, Fe, a sequence consistent with observations in various alpine lakes. More than 50% of the dissolved inputs of each metal was retained in the lake, except for Cu, which appeared to show a small net loss from the lake. (Author's abstract) W91-02587 W91-02587

SULFUR STORAGE AND ALKALINITY GEN-ERATION IN NEW ENGLAND LAKE SEDI-MENTS

Marine Biological Lab., Woods Hole, MA. Ecosystems Center. For primary bibliographic entry see Field 2H. W91-02588

ANNUAL MEAN TRANSPORT IN PUGET SOUND

National Oceanic and Atmospheric Administra-tion, Seattle, WA. Pacific Marine Environmental

E. D. Cokelet, R. J. Stewart, and C. C.

Ebbesmeyer. Available from the National Technical Information Service, Springfield, VA 22161. NOAA Technical Memorandum ERL PMEL-92, July 1990. 59 p. 12 fig, 15 tab, 55 ref, append.

Descriptors: \*Estuaries, \*Model studies, \*Path of pollutants, \*Puget Sound, Data interpretation, Hydrologic models, Runoff, Salinity, Strait of Juan de

The increasing urbanization of the Puget Sound region is resulting in concern about the long-term circulation of the Sound and its relationship to the region is resulting in concern about the long-term circulation of the Sound and its relationship to the transport and dispersal of pollutants. As part of a study of this problem, a project was undertaken to calculate systematically the annual mean runoff, salinity and transport of the Sound. Puget Sound was modeled as a branched system of two-layered advective reaches separated by mixing zones. Fresh-water and salt-water provide convenient tracers to calculate the annual mean layer transports. The technique used historical records (1951-1956) of runoff and salinity which were analyzed with the aid of modern (principally in the 1970s) current meter records to provide the appropriate mass conserving landward-flowing and seaward-flowing layer salinities for each reach. For the first time long-term transports have been estimated simultaneously for the entire Strait of Juan de Fuca/Puget Sound system. With few exceptions the inferred transports agree well with estimates derived from scattered, shorter duration current observations. Uncertainties in the transports are estimated from uncertainties. The analyzed runoff and salinity data sets and the inferred transports provide a foundation for applying the reflux theory to Puget Sound. (Lantz-PTT) W91-02615

CHARACTERIZATION OF YEAR-ROUND SENSITIVITY OF CALIFORNIA'S MONTANE LAKES TO ACIDIC DEPOSITION.

California Univ., Santa Barbara. Marine Science

J. O. Sickman, and J. M. Melack.

J. O. Sickman, and J. M. Melack.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-215552.
Price codes: A04 in paper copy, A01 in microfiche.
Final Report, June 1989. 104 p, 44 fig. 19 tab, 25 ref. California Air Resources Board Contract A5-

Descriptors: "Acid rain, "California, "Mountain lakes, "Path of pollutants, "Water pollution sources, Acetates, Ammonium, Crystal Lake, Hydrogen, Hydrogen ion concentration, Nitrates, Pear Lake, Ruby Lake, Seasonal variation, Sierra Lake, Snow, Sulfates, Topaz Lake.

Four high elevation lake watersheds in the Sierra Four high elevation lake watersheds in the Sierra Nevada were studied from October 1986 through June 1988. Researchers measured wet deposition, lake outflow, and lake chemistry and physics at these sites using the mass balance approach to relate the effect of wet deposition on lake and stream water chemistry. Crystal and Ruby Lakes, located on the eastern slope of the Sierra, and Topaz and Pear Lakes, located on the western alope in Sequoia National Park, were found to be dimictic. Major solute concentrations in the subsurface reached a minima during the latter part of snowmelt. Near-hottom concentrations of these sosurface reached a minima during the latter part of snowmelt. Near-bottom concentrations of these solutes generally had less seasonal variation and were generally higher than subsurface values. Mean snow depth and chemical concentrations were similar for the winters of 1986-87 and 1987-88 at all watersheds. Volume-weighted mean pH ranged from 5.3 to 5.5, with the dominant ions being home 3.5 to 3.5, with the dominant lons deing hydrogen, ammonium, acetate, nitrate and sulfate. Wet deposition as mixed rain and snow occurring between May and October can deliver more solutes to the watersheds than winter snows. (Autority of the control of the thor's abstract) W91-02619

WETLAND AREAS: NATURAL WATER TREATMENT SYSTEM (JAN 78 - AUG 89). CI-TATIONS FROM THE POLLUTION AB-STRACTS DATABASE. WATER

Davis (J.J.) Associates, Inc., McLean, VA.
For primary bibliographic entry see Field 5D.
W91-02642

SUMMARY OF RISK ASSESSMENT METH-ODOLOGIES FOR MUNICIPAL SLUDGE REUSE OR DISPOSAL OPTIONS.

Environmental Protection Agency, Cincinnati, OH. Office of Research and Development. For primary bibliographic entry see Field 5E. W91-02666

SEDIMENT-WATER-EQUILIBRIA: THE SORPTION OF VOLATILE CHLORINATED HYDROCARBONS AND DICHLORO BENZENES BY SEDIMENTS. (SEDIMENT-WASSER-GLEICHGEWICHTE: VERHALTEN

WASSER-GLEICHGEWICHTE: VERHALTEN FLUCHTIGER CHLDRKOHLENWASSER STOFFE UND DER DICHLORBENZOLE AN GEWASSERSEDIMENTEN.
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
R. Weinberg, U. Forstner, T. Haug, and W. Kienz. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-764537. Price codes: AO6 in paper copy, AO1 in microfiche. Report No. NP-9764537. December 1987. 113p, 46 fig, 20 tab, 132 ref. English summary.

Descriptors: \*Fate of pollutants, \*Organic pollutants, \*Path of pollutants, \*Sediment chemistry, \*Sediment-water interfaces, \*Sorption, Anions, Benzene, Cations, Chlorinated hydrocarbons, Germany, Hydrogen ion concentration, Methane, Temperature effects.

Sorption of selected organic contaminants by aquatic sediments was examined. The sorbates used aquatic sediments was examined. The sorbates used were dichloro methane, trichloro methane, 1,1,1-

#### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

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trichloro ethane, trichloro ethene, tetrachloro ethene and 1,2-, 1,3-, as well as 1,4-dichloro benzene. For comparison parathion and hexachloro benzene were also used in the experiments. The sediments were taken from a freshwater tidal segments were taken from a freshwater tidal marsh of the Elbe river near the city of Hamburg. Sorption equilibria were reached in less than one hour. Sorption was generally reversible and was adequately described by linear partition coeffi-cients. Sorption increased with increasing organic cients. Sorption increased with increasing organic carbon content of the sediments. The sorption coefficients of a compound based on the organic carbon fraction, Koc, however, were almost equal for all sediments tested. Sorption experiments under varied conditions had the following results:

(1) Sorption decreased with increasing temperature. The sorption enthalpies are about 8.6 kJ/mol for all sediments and dichlorobenzenes; (2) The pH has no effect on the sorption of the dichlorobenzenes; (3) Increasing the salinity enhances the sorptions. zenes; (3) Increasing the salinity enhances the sorption; (4) Acetic acid, NTA, as well as methanol introduced to concentrations up to some g/L, showed no effect; and (5) Detergents caused a marked desorption at concentrations above their marked desorption at concentrations above their critical micelle concentrations. The anionic com-pound TBS, however, enhanced the sorption of an acidic sediment (pH 3.5), when the concentration of the detergent was increased. The cationic TCAB exhibited at concentrations somewhat below the critical micelle concentration a marked increase of the sorption of DCB, Parathion and HCB. These phenomena can be explained by the surface charge characteristics of the sediment particles. (Author's abstract) W91-02668

OIL SLICK SIZES AND LENGTH OF COAST-LINE AFFECTED: A LITERATURE SURVEY AND STATISTICAL ANALYSIS-FINAL

Minerals Management Service, Los Angeles, CA. Pacific OCS Region.

G. G. Ford.

G. G. Ford.

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-204648/AS. Price codes: A03 in paper copy, A01 in microfiche. Report No. MMS 85-0105, October 1985. 37p, 7 fig. 5 tab, 68 ref.

Descriptors: \*Coastal waters, \*Oil pollution, \*Oil spills, \*Path of pollutants, \*Statistical analysis, Mathematical equations, Model studies, Prediction, Regression analysis.

An historical and statistical analysis of the size of An instorical and statistical analysis of the size of oil slicks at sea and the length of coastline affected by oil slicks which come ashore was undertaken. A total of 21 incidents which included descriptions of slick sizes at sea, and 39 incidents which included descriptions of the amount of coastline oiled were sites asses at sea, and 39 incidents which included descriptions of the amount of coastline oiled were located in the literature. Only incidents for which estimates of oil outflow were available were accepted. Stepwise multiple linear regression was used to determine which factors were the most accurate predictors of slick size and coastline affected. A regression model was developed which could account for 90.1% of the variation in slick size based on spill volume, age of spill, wind speed, and wave height. A simplified equation based only on spill volume and age—assuming the average wind and wave conditions in the Southern California Bight-was presented. The variation in slick sizes which was not explained by the regression model was used to construct a model to estimate the probability that a spill of a given volume and age would reach a particular size. Stepwise regression was also used to build a predictive model of age would reach a particular size. Stepwise regression was also used to build a predictive model of the length of coastline affected by a spill which comes ashore. Only two variables, spill volume and latitude, contributed significantly to the prediction of coastal oiling. These two variable accounted for 64.8% of the variation in the length of coastline affected. As with slick sizes, a model based on the unexplained variance in length of coastline affected was constructed to estimate the probability that a spill of a given volume would affect a given length of coastline. (Author's abstract) stract) W91-02671

TEMPORAL VARIABILITY OF WATER QUALITY AND THE IMPLICATIONS FOR

MONITORING PROGRAMMES IN IRISH LIMESTONE AQUIFERS.
Trinity Coll., Dublin (Ireland). Environmental Sci-

For primary bibliographic entry see Field 7A. W91-02682

EFFECT OF FIELD-SCALE SOLUTE INFIL-TRATION INTO GROUNDWATER ON SUR-FACE WATER QUALITY. Royal Inst. of Tech., Stockholm (Sweden). Dept.

Royal Inst. of Tech., Stockholm (Sweden). Dept. of Hydraulics Engineering. C. S. Kung, G. Destouni, and V. Cvetkovic. IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 121-129, 6 fig, 12 ref.

Descriptors: \*Agricultural runoff, \*Groundwater quality, \*Nonpoint pollution sources, \*Path of pollutants, \*Surface-groundwater relations, \*Water pollution sources, Adsorption-desorption, Advection, Aeration zone, Groundwater management, Groundwater movement, Infiltration, Solute transport, Solutes, Water quality management, Water

The impact of agricultural activities on water quality is a problem of growing interest. Different substances that are soluble in water are spread over large areas and may leach through the unsaturated zone into the groundwater, following groundwater movement, eventually reaching surface water and public supply wells. Decisions on appropriate adpublic supply weits. Decisions on appropriate ac-ministrative and technical measures are based on the assessment of potential hazards that may arise due to groundwater quality changes. In order for the potential hazard to be assessed in an objective manner, the uncertainty in predictions of regional solute transport needs to be quantified. The effect of field-scale infiltration on surface water quality was analyzed. A hypothetical example, where solute leaches from a heterogeneous field and is transported through the aquifer to surface water, was examined. Both conservative and reactive solutes were considered, where the assumed reaction was first order non-equilibrium sorption-desorp-tion. The influence of variability in the parameters that control advection in the unsaturated zone decreases with the distance from the source area. This effect is more pronounced for a conservative than for a reactive solute. The effect of sorptiondesorption in the unsaturated zone on regional movement of solute is to decrease the expected movement of solute is to decrease the expected peak concentration and reduce the influence of field heterogeneity. The results on regional solute transport are primarily qualitative and provide an indication of the uncertainty that may be expected in field applications. (See also W91-02672) (Fisherenes) PTT) W91-02683

PREDICTION OF THE CONCENTRATION DISTRIBUTION OF GROUNDWATER POL-LUTANTS.

Kyushu Univ., Fukuoka (Japan). Dept. of Civil Engineering. K. Jinno, A. Kawamura, T. Ueda, and H.

Yoshinaga.

Yoshinaga.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 131-142, 7 fig, 7 ref.

Descriptors: \*Decision making, \*Groundwater pollution, \*Groundwater quality, \*Model studies, \*Path of pollutants, Aquifer characteristics, Convection, Dispersion, Fourier analysis, Groundwater er management, Groundwater movement, Mathematical models, Stochastic models, Water quality management, Water resources management.

When a convective-dispersive phenomenon of groundwater pollutants is analyzed, its mechanism should be regarded as stochastic, because of many uncertainties in the interaction between pollutant and flow. A method based on the Fourier series expansion and the extended Kalman filter has been developed to identify the parameters of a onedimensional constant coefficient stochastic convective-dispersive equation and to predict the concentration distribution of groundwater pollutants. This method was compared with two synthetically gen-erated concentration distributions: one with conerated concentration distributions: one with constant physical parameters and the other with spatial change in the physical parameters. The results obtained showed that the proposed method would be able to predict the concentration distribution and identify the parameters accurately. (See also W91-02672) (Fish-PTT) W91-02684

INFLUENCE OF PRECIPITATION ON THE QUALITY OF KARST GROUNDWATER IN IN-

DUSTRIAL ZONES.
Belgrade Univ. (Yugoslavia). Faculty of Mining and Geology.
N. Kresic, P. Papic, and R. Golubovic.
IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 153-159, 4 fig, 2 tab, 3 ref.

Descriptors: \*Acid rain effects, \*Air pollution effects, \*Groundwater quality, \*Karst hydrology, \*Water pollution sources, Acid rain, Correlation analysis, Geohydrology, Groundwater management, Hydrogen ion concentration, Industrial wastes, Mineralization, Nitrates, Precipitation, Regression analysis, Serbia, Spring water, Sulfates, Water quality management, Water resources management, Yugoslavia.

Complex hydrogeological researches on karst aquifers in western Serbia, Yugoslavia, conducted for water supply purposes, found an increased content of some hydrochemical components in tent of some hydrochemical components in groundwater. The groundwater quality in an im-portant karst aquifer in the vicinity of Valjevo, a large industrial center in western Serbia, has wors-ened during the last few years. An increased con-tent of nitrates and sulfates is caused by acid rain. Its influence was analyzed daily for two years, with next increase at the pairs and to the coringer with particular attention being paid to the regimes of nitrates, sulfates, pH values, and mineralization both in precipitation and spring discharge, depth of precipitation, and spring discharge. Connections between these elements were established through correlation and regression analysis. It was conclud-ed that further industrialization without preventing the emission of pollutants might cause an exceedance of the permitted limits in the near future. (See also W91-02672) (Author's abstract) W91-02686

THREAT TO GROUNDWATER QUALITY BY PESTICIDES IN THE NETHERLANDS.

Rijksinstituut voor de Volksgezondheid, Bilthoven

(Netnertands).
P. Lagas, B. Verdam, and J. P. G. Loch.
IN: Groundwater Management: Quantity and
Quality. Proceedings of the Symposium held at
Benidorm, Spain, October 2-9, 1989. International
Association of Hydrological Sciences, Washington, DC. 1989. p 171-180, 3 fig. 4 tab, 4 ref.

Descriptors: \*Groundwater pollution, \*Groundwater quality, \*Nonpoint pollution sources, \*Path of pollutants, \*Pesticides, \*The Netherlands, \*Water pollution sources, Agricultural chemicals, Decomposition, Drinking water, Groundwater management, Leaching, Monitoring, Organic pollutants, Water quality management, Water quality standards, Water resources management, Water

Since the early 1980s, monitoring studies for pesticide residues in groundwater have been conducted in several countries. In the Netherlands, pesticide admission requires the estimation of their leaching potential to groundwater. To assess the risk of groundwater pollution by pesticides in the Netherlands, the occurrence and behavior of selected pesticides in the upper groundwater was investigated. On land with potatoes, maize, and flower bulb culture, and on uncropped land, filter tubes were placed for periodic sampling and analysis. So far, 21 different organic compounds have been

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detected in groundwater as a consequence of the application of pesticides. The highest concentrations found involve persistent admixtures and decomposition products, which are more polar and thus more mobile in the soil than the parent compound. Apart from the pesticides, decomposition products and admixtures are a threat to groundwater quality and drinking water supply. (See also W91-02672) (Author's abstract) W91-02688

NITRATE IN GROUNDWATER.

Hanover Univ. (Germany, F.R.). Inst. fuer Wasser-wirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.

Wasserbau.
W. Meier, and R. Mull.
IN: Groundwater Management: Quantity and
Quality. Proceedings of the Symposium held at
Benidorm, Spain, October 2-9, 1989. International
Association of Hydrological Sciences, Washington, DC. 1989. p 181-190, 6 fig. 2 tab, 6 ref.

Descriptors: \*Groundwater management, \*Groundwater quality, \*Nitrates, \*Water pollution prevention, \*Water quality management, \*Water resources management, Animal wastes, Cattle, Fertilizers, Forecasting, Germany, Groundwater pollution, Hydrologic models, Model studies, Path of pollutants, Pump wells, Waste disposal, Water quality standards, Watershed management, Well construction, Wells.

An intensive intrusion of nitrate into many aquifers has occurred in the last 20 years. Measures are being taken to prevent high concentrations of this pollutant in pumping wells. In the long run a less intensive use of mineral fertilizers and a diminished pollutant in pumping wells. In the long run a less intensive use of mineral fertilizers and a diminished disposal of livestock wastes in the catchment areas of pumping wells are the prerequisitions for an acceptable concentration of nitrate in groundwater. Before these measures take effect, hydraulic measures are convenient to avoid the pollution of abstracted groundwater: pumping wells have to be placed at locations with low nitrate concentrations and pumping strategies must be applied to keep the nitrate concentration below the tolerable standard of 50 mg/L NO3. Groundwater modeling was applied to forecast the effects of different measures, such as the installation of new pumping wells, deeper screens, or special pumping strategies, on a site in northern Germany. Such solutions are effective in decreasing the concentrations of the contaminant in the discharged groundwater within the tolerable standard. (See also W91-02672) (Author's abstract)

### CHARACTERIZING THE HYDROGEOLOGI-CAL VARIABILITY OF A SAND AQUIFER IN THE REGION OF A DOMESTIC WASTE DIS-POSAL SITE

Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water

RESOUTCES.

R. B. Salama, G. B. Davis, and C. Barber.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 215-225, 7 fig, 17 ref.

Descriptors: \*Geohydrology, \*Groundwater movement, \*Groundwater pollution, \*Groundwater quality, \*Path of pollutants, \*Sand aquifers, \*Water pollution sources, Aquifer characteristics, Domestic wastes, Flow velocity, Geophysical surveys, Groundwater management, Hydraulic conductivity, Landfills, Plumes, Solute transport, Tracers, Waste disposal, Water chemistry, Water quality management, Water resources management.

A multidisciplinary approach was adopted to define pollution plume development in a sand aquifer at a landfill site. Aquifer parameters, water quality changes, and plume development were determined through detailed hydrogeological investigations and regular hydrochemical monitoring and geophysical surveys. Hydraulic conductivities esti-mated from grain size analyses were confirmed by estimates obtained from a tracer test and gave

groundwater velocities in the range 60-100 m/year. This is in agreement with the rate of plume advancement. Data collected from the field studies were used in a groundwater flow and solute transport model to predict the rate of pollution plume development and provide a basis for aquifer management in the vicinity of the site. Further work in progress to integrate the microscale variations of the hydraulic conductivity, as indicated by the tracer test, to estimate better the critical parameters of the plume scale dispersivity. Although apparently a uniform sand, the aquifer underlying the landfill shows significant microscale variability, particularly of the hydraulic conductivity, which suggests variable pollution velocities. It is, therefore, critical to appraise properly the likelihood of such variability in any remedial work at a landfill site. (See also W91-02672) (Fish-PTT)

DECOMPOSITION AND ELIMINATION OF TYPICAL POLLUTANTS FROM SANITARY LANDFILLS IN POROUS AQUIFERS. Technische Univ. Braunschweig (Germany, F.R.). Leichtweiss-Inst. fuer Wasserbau und Grundbau.

P. Spillmann.

P. Spillmann.
IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 227-233, 3 fig, 2 ref.

Descriptors: "Fate of pollutants, "Groundwater pollution, "Groundwater quality, "Landfills, "Path of pollutants, "Sanitary landfills, Aquifers, Atrazine, Bacteris, Chemical oxygen demand, Decomposition, Germany, Groundwater management, Landfill covers, Leachates, Leaching, Lindane, Loam, Pathogens, Pesticides, Sand, Simazine, Solute transport, Water quality management, Water resources management.

In the past, sanitary landfills were not sealed or drained and it is not absolutely certain that a modern sealing would be completely impermeable today and in the future. Groundwater pollutants caused by sanitary landfills are currently being investigated in defined artificial aquifers in an interdisciplinary research project in Germany. In order to measure the transport and the elimination of the substances polluting the groundwater, the following method was selected: a defined quantity of leachate from a refuse dump is added to an of the substances polluting the groundwater, the following method was selected: a defined quantity of leachate from a refuse dump is added to an artificial aquifer where there is a definite flow path. The load of the added leachate is then compared to the load of the outflow. The leachate both from a freshly built landfill and from an old, biologically decomposed dump is investigated under parallel conditions. In the same way, the effect of a porous covering layer of sand is compared with a barely permeable covering layer of compacted loam. This gives a total of four parallel artificial aquifers, each of which permits investigations to be made concerning the transport and decomposition of pollutants from dumps and sanitary landfills. In addition to the leachate, germs, 2-3-dichlorphenol, Simazine, Atrazine, Lindane, and Coli bacteria are added. Initial results of the research show that the remaining load-constant chemical oxygen demand is converted further into substances similar to natural substances and that the organic substances of the leachate from refuse encourage the decomposition of various synthetic organic compounds. (See also W91-02672) (Fish-PTT) W91-02693

#### COUPLING OF CHEMISTRY AND TRANS-

PORT.
Gesamthochschule Kassel (Germany, F.R.).
W. Kinzelbach, and W. Schafer.
IN: Groundwater Management: Quantity and
Quality. Proceedings of the Symposium held at
Benidorm, Spain, October 2-9, 1989. International
Association of Hydrological Sciences, Washington, DC. 1989. p 237-259, 16 fig. 20 ref.

Descriptors: "Fate of pollutants, "Groundwater pollution, "Hydrologic models, "Model studies, "Path of pollutants, "Solute transport, Cations, Chemical interactions, Groundwater management, Heterogeneity, In situ treatment, Mathematical

models, Model testing, Nitrates, Numerical analysis, Water quality management, Water resources

There is virtually no pollutant or solute in ground-water which will not eventually undergo chemical transformation including adsorption, reaction, spewater which will not eventually undergo chemical transformation including adsorption, reaction, speciation, complexation, etc. A correct interpretation of concentration data in groundwater requires a coupled model of transport and chemical processes. Coupling of non-trivial chemical models to transport models results in systems of non-linear partial differential equations and algebraic equations. The split-operator method has been used in their numerical solution. Two applications of chemical models coupled to transport were examined: a cation (heterogeneous fast reaction) and a nitrate system (a heterogeneous slow reaction). For field applications there is a competition between transport and chemistry which can only be evaluated with three-dimensional or horizontally two-dimensional models: a breakthrough of nitrate in a well can be caused either by nitrate passing by the spill or by nitrate being no longer used up by microbial activity in the spill itself. Coupled models allow these effects to be considered and can therefore be useful in the design of an in situ remediation. Ambiguity in identifying the model parameters can be diminished if the parallel transport of several components is observed and interpreted. These models may well be used for purposes such as testing of hypotheses, gaining insight into system behavior, and interpretation of column experiments. (See also W91-02672) (Fish-PTT) W91-02694 W91-02694

#### IDENTIFICATION OF UNSATU SOLUTE TRANSPORT PARAMETERS. UNSATURATED

Pontificia Univ. Catolica de Chile, Santiago. Faculty of Engineering. R. Abeliuk.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 261-270, 1 fig, 3 tab, 14 ref.

Descriptors: \*Hydrologic models, \*Model studies, \*Path of pollutants, \*Solute transport, Algorithms, Convection, Dispersion, Flow models, Groundwater management, Hydrodynamics, Hydrologic data, Numerical analysis, Optimization, Parametric hydrology, Soil contamination, Soil moisture, Unsaturated flow, Water quality management, Water resources management.

Although a number of analytical solutions of par-tial differential equations have been developed to describe one-dimensional solute transport, these sodescribe one-dimensional solute transport, these solutions are only applicable to specific cases where simplifying assumptions can be made. A general model of solute transport must include the equations for flow and solute transport, with terms included as appropriate to account for physical, chemical, or biological interactions of the solute with the soil environment. The problem of parameter identification is probably the major restriction on the practical application of comprehensive numerical models of unsaturated solute transport. An optimization algorithm with two different forms of the objective function was used to estimate the parameters governing the convection-dispersion equation for the transport of solutes under unsaturated flow conditions. The results show that at least two forms of the coefficient of hydrodynamic dispersion produce identical performance when least two forms of the coefficient of hydrodynamic dispersion produce identical performance when used to simulate the transient transport of a non-reactive solute in a column of unsaturated soil, confirming that the form of this coefficient is ambiguous when identified from transient moisture content/solute profiles, and hence indicating that interpretation of analytical forms from experimental data must be carried out with great caution. When a lease number of parameters are estimated. when a large number of parameters are estimated the optimization technique generates various parameter sets that reproduce the calibration data adequately for both types of objective function. However, when the number of parameters de-creases, the technique identifies unique parameter values. In all cases, however, the estimated param-

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eter sets are robust in prediction. (See also W91-02672) (Fish-PTT) W91-02695

STOCHASTIC CONTROL OF CONTAMINANT TRANSPORT PROBLEMS.

Minnesota Univ., Minneapolis. St. Anthony Falls For primary bibliographic entry see Field 5G. W91-02696

RELEVANCE OF THE TRANSPORT PARAMETERS IN PREDICTIVE MODELLING OF GROUNDWATER CONTAMINATION. Waterloo Univ. (Ontario). Inst. for Ground Water

Research.
E. O. Frind, and J. W. H. Molson.
IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 331-347, 11 fig. 8 ref.

Descriptors: \*Groundwater movement, \*Ground-water pollution, \*Hydrologic models, \*Model studies, \*Path of pollutants, \*Water quality man-agement, \*Water resources management, Aquifer characteristics, Canada, Decision making, Disper-sion, Flow equations, Flow models, Flow system, Groundwater management, Groundwater quality, Plumes, Three-dimensional model.

To protect groundwater quality, it must be understood how contaminants migrate in groundwater systems, and it must be known what and how much information is needed to predict such migrasystems, and it must be known what and now much information is needed to predict such migration. In real situations under irregular aquifer geometry, the controlling factors on the propagation of a plume may not be the dispersion parameters, but the flow field. A three-stage modeling approach that produces a fully three-dimensional plume was developed to compare the effects due to dispersion to those due to the flow field. The propagation of the well-monitored Borden (Toronto, Canada) contaminant plume was simulated in three dimensions. The results show that plume propagation is strongly controlled by the three-dimensional flow field. The most relevant parameters for the simulation were found to be those that govern the three-dimensional flow field, namely the stratigraphy, the aquifer geometry, the hydraulic conductivity, and the flow boundary conditions. To verify the prediction of asymmetry, the aquifer stratigraphy and recharge pattern should be confirmed by independent measurements. Dispersion, although important, plays a less controlling the decision which is a decision which is the single pattern should be confirmed by independent measurements. Dispersion, although important, plays a less controlling the stratigraphy and recharge decision which admits a decision which is the stratigraphy and recharge pattern should be confirmed by independent measurements. Dispersion, although important, plays a less controlling the stratigraphy and recharge decision which admits the stratigraphy and recharge decision which are the stratigr be contrimed by independent measurements. Dis-persion, although important, plays a less control-ling role. The implication on the decision-making process in groundwater resource investigations is that primary data acquisition should focus on de-fining the three-dimensional groundwater flow system. (See also W91-02672) (Fish-PTT) W91-02701

LOCALIZED ADJOINT METHODS: APPLICA-TION TO ADVECTION DOMINATED FLOWS. Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Geofisica. For primary bibliographic entry see Field 2F. W91-02702

FINITE ELEMENT GROUNDWATER MODEL AS ESSENTIAL PLANNING TOOL: MICRO-BIOLOGICAL DENITRIFICATION OF A WELL FIELD AT BROICHHOP. Lahmeyer International G.m.b.H., Frankfurt am Main (Germany, F.R.).
For primary bibliographic entry see Field 5F.
W91-02703

NUMERICAL MODEL FOR SIMULATING THE IN-SITU VOLATILIZATION OF HYDRO-CARBON CONTAMINANTS IN SOILS. Colorado State Univ., Fort Collins. Dept. of Civil

Engineering.

G. P. Sabadell, D. K. Sunada, and N. S. Grigg.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International

Association of Hydrological Sciences, Washington, DC. 1989. p 381-391, 4 fig, 13 ref.

Descriptors: \*Fate of pollutants, \*Hydrocarbons, \*Hydrologic models, \*Model studies, \*Oil spills, \*Path of pollutants, \*Petroleum products, \*Pollutant transport, \*Soil contamination, \*Volatile organic compounds, \*Volatilization, \*Water resources management, Advection, Aeration zone, Free water, Groundwater management, Groundwater pollution, In situ treatment, Soil treatment, Soil water, Solute transport, Three-dimensional model, Volatility, Water quality management.

In recent years contamination of groundwater by industrial chemicals, especially petroleum products and halogenated solvents, has become a problem of major concern. A three-dimensional model of the advective transport of volatile organic contaminants in the gaseous phase of the unsaturated zone has been developed and tested against selected analytical solutions. The model accounts for the unsaturation of contaminants from a pure limit analytical solutions. The model accounts for the evaporation of contaminants from a pure liquid surface, partitioning of a contaminant from an aqueous solution and the adsorption/desorption of organics with soil particle surfaces. The results predict the concentrations of volatile organics throughout the soil profile allowing the user to estimate the amounts of hydrocarbons leaving the soil via volatilization. The model can aid the analysis, design, and operation of remediation efforts using an In Situ Volatilization (ISV) system. The ISV is used to prevent volatile organic compounds using an in Situ Volatilization (ISV) system. The ISV is used to prevent volatile organic compounds from migrating with infiltrating water through the vadose zone to the underlying groundwater table. (See also W91-02672) (Author's abstract) W91-02705

MODELLING OF FLOW AND CONTAMI-NANT TRANSPORT IN A CONJUNCTIVELY MANAGED GROUNDWATER BASIN: A CASE

STUDY. California Univ., Davis. Dept. of Agricultural Ec-

A. Taghavi, M. A. Marino, and R. E. Howitt. S. A. Taghavi, M. A. Marino, and R. E. Howitt.
In: Groundwater Management: Quantity and
Quality. Proceedings of the Symposium held at
Benidorm, Spain, October 2-9, 1989. International
Association of Hydrological Sciences, Washington, DC. 1989. p. 405-418, 8 fig. 16 ref. University
of California Water Resources Center Project
UCAL-WRC-W-692.

Descriptors: \*Artificial recharge, \*Conjunctive use, \*Flow models, \*Groundwater management, \*Groundwater models, \*Groundwater models, \*Pollutant transport, \*Water quality management, \*Water resources management, California, Farm wastes, Fate of pollutants, Groundwater basins, Groundwater pollution, Nitrates, Numerical analysis, Overdraft, Path of pollutants, Recharge basins, Watershed management.

Groundwater quality and quantity in the Chino basin, California, have been seriously affected by agricultural, industrial, and municipal developments during the past few decades. Increasing water demands have caused overdraft of the groundwater while indiscriminate disposal of agricultural and dairy wastes have contributed to the downgrading of the quality of the groundwater. To remedy the overdraft problem, imported water from the State Water Project is to be used in conjunction with the local groundwater through artificial recharge. However, there is currently no plan for controlling and reducing high levels of nitrate in the aquifer. A numerical simulation model was used to study the hydraulic response of the aquifer to the recharge program and to analyze model was used to study the nydratuic response or the aquifer to the recharge program and to analyze the feasibility of recharge basins. The model simu-lates two-dimensional regional changes in the water table over time. Also, a mass transport model was used to simulate the movement and fate of nitrate in the aquifer considering the recharge of nitrate in the aquifer considering the recharge program with the existing rate of waste disposal. Results of the water quality model show that the recharge program using the proposed recharge facilities would not alter the nitrate levels. However, if the existing recharge basins in the southern portion of the Chino basin were to be used, the nitrate levels would be expected to decrease considerably or not increase at the current rate over the next 15-20 years. (See also W91-02672) (Au-W91-02707

APPLICATION OF GROUNDWATER MODEL-LING IN WATER RESOURCES MANAGE-MENT IN DENMARK.

Miljoestyrelsen, Copenhagen (Denmark) M. Dyhr-Nielsen.

In: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 559-570, 6 ref.

Descriptors: \*Aquifer management, \*Denmark, \*Groundwater resources, \*Irrigation effects, \*Model studies, \*Streamflow depletion, \*Surface-groundwater re-"Streamtow depletion, "Surface-groundwater re-lations," Water resources management, "Water supply development, Agricultural chemicals, Case studies, Environmental policy, Groundwater pollu-tion, Hydrologic models, Leachates, Management planning, Minimum flow, Nitrates, Path of pollut-ants, Research priorities, Water pollution control.

With a water supply almost entirely dependent on groundwater, Denmark has extensive experience in management and control of groundwater re-Natural recharge is mostly sufficient to satisfy the water supply needs except in the most populated areas around major cities like Copenhagen. However, a policy of water resource manage-ment based on environmental impacts has made stream depletion the most important constraint for water development. To achieve rational estimates of the potential effects of groundwater develop-ments on streamflow, extensive investigations and model tools have been developed on the initiative of the National Agency of Environmental Protecof the National Agency of Environmental Protec-tion. Also the more recent water resources prob-lems associated with agricultural nitrate pollution and leaching of chemical wastes has led to the initiation of major interdisciplinary research pro-grams. Developments in Danish water resources management have progressed from a case-by-case basis to comprehensive pollutant control programs. Some major research projects initiated in connec-tion with important management issues include the deterministic of steemflow denietion nitrate poltion with important management issues include the determination of streamflow depletion, nitrate pollution from agriculture, and reclamation of groundwater polluted by chemical wastes. (See also W91-02672) (Author's abstract) W91-02719

ORIGINS OF ACID RUNOFF IN A HILLS-LOPE DURING STORM EVENTS.

Sveriges Lantbruksuniversitet, Umea. Dept. of Forest Site Research. For primary bibliographic entry see Field 5C. W91-02737

EVIDENCE FOR LONG-TERM DETERIORA-TION OF STREAMWATER CHEMISTRY AND SOIL ACIDIFICATION AT THE BIRKENES CATCHMENT, SOUTHERN NORWAY. Senter for Industriforskning, Oslo (Norway)

For primary bibliographic entry see Field 5C. W91-02738

REVERSAL OF STREAM ACIDIFICATION AT THE BIRKENES CATCHMENT, SOUTHERN NORWAY: PREDICTIONS BASED ON POTEN-TIAL ANC CHANGES.

Senter for Industriforskning, Oslo (Norway). N. Christophersen, C. Neal, and J. Mulder. Journal of Hydrology JHYDA7, Vol. 116, No. 1/ 4, p 77-84, August 1990. 1 fig. 2 tab, 18 ref.

Descriptors: \*Acid neutralizing capacity, \*Acid rain effects, \*Acid streams, \*Acidification, \*Fish stocking, \*Norway, \*Soil chemistry, \*Streams, \*Sulfur, \*Water quality trends, Acid rain, Acidic soils, Air pollution effects, Cations, Emission control, Fish, Fish establishment, Soil water, Sulfur oxides, Trout.

#### Sources Of Pollution-Group 5B

As western European sulfur emissions continue to decline following peak levels in the 1970's, interest is now focusing on the reversibility of freshwater acidification. Streamwater and soilwater data from the Birkenes catchment in southern Norway were considered in an attempt to estimate the minimum reductions of sulfur deposition required to reintroduce brown trout to the stream. The approach taken was to derive a lower bound for the required reduction based on a suitable definition of the acidneutralization capacity (ANC). The results demonstrate that, for present soil conditions and atmospheric base cation inputs, a decrease of sulfate deposition of more than 85%, from 1985-1987 levels, is needed to allow successful restocking of brown trout. Since this is a minimum estimate, it is possible to envisage several mechanisms by which streamwater acidification would not be sufficiently reversible for fish survival even at 100% reduction in sulfur deposition. (Author's abstract) W91-02739

ELEMENT BUDGETS OF TWO CONTRAST-ING CATCHMENTS IN THE BLACK FOREST (FEDERAL REPUBLIC OF GERMANY).

(FEDERAL REPUBLIC OF GERMANY). Freiburg Univ. (Germany, F.R.). ic of Soil Science and Forest Nutrition. K. H. Feger, G. Brahmer, and H. W. Zottl. Journal of Hydrology JHYDA7, Vol. 116, No. 1/ 4, p 85-99, August 1990. 5 fig, 5 tab, 29 ref. Nuclear Research Center Karlsruhe Grant 86/012/1A.

Descriptors: \*Acid rain, \*Black Forest, \*Forest hydrology, \*Forest watersheds, \*Geochemistry, Descriptors: "Actd rain, "Black Forest, "Forest hydrology, "Forest watersheds, "Geochemistry, "Germany, "Rainfall-runoff relationships, Drainage patterns, Dry deposition, Forest management, Geochemical cycles, Hydrologic budget, Ion transport, Nitrogen, Precipitation, Rainfall, Runoff, Soil organisms, Soil types, Soil water, Stream discharge, Sulfur, Throughfall, Topogra-

Rainfall and throughfall inputs of all major cations and anions, via open-field bulk precipitation and canopy throughfall, are compared with stream-water outputs in two forested catchments at higher altitudes of the Black Forest. The sites differ con-siderably in terms of bedrock geology, soil type, siderably in terms of bedrock geology, soil type, soilwater characteristics, topography, and forest management history. Chemical deposition at both sites is almost equal and, in contrast to other forest areas in Central Europe, of a low-to-moderate level. Dry deposition does not seem to play an important role. Distinct differences in the elemental states are seemed to the difference in the elemental states. important role. Distinct differences in the elemental output emerge owing to the differing site conditions. At Villingen, deposited nitrogen is almost totally retained, whereas at Schluchsee, nitrogen output and input are of the same order of magnitude. This is consistent with the different nitrogen nutrition level of the stands, microbial turnover in the soil, and former management practices (change of tree species, excessive nutrient export). Sulfur not retained in either of the catchments. At Schluchsee, sulfur export exceeds input from canopy throughfall by a factor of 2.5. The higher output rates, both of nitrogen and sulfur at Schluchsee, are due to the much higher microbial mineralization of organic matter as shown by pre-vious incubation tests. Differences in cation and proton export are mainly caused by a difference in drainage pattern. In contrast to the Schluchsee drainage pattern. In contrast to the Schluchsee catchment, where vertical water pathways prevail, the streamwater solute output at Villingen is dominated by a shallow subsurface runoff. Atmospheric deposition is a contributing, but not the dominant factor in the biogeochemical cycling at these sites. Hence, a generally applicable quantitative definition of critical loads, especially for nitrogen, is illusory and the use of such numbers will be misleading. (Author's abstract)

INFLUENCE OF ACID ATMOSPHERIC INPUTS ON SURFACE WATER CHEMISTRY AND MINERAL FLUXES IN A DECLINING SPRUCE STAND WITHIN A SMALL CATCHMENT (VOSGES MASSIF, FRANCE). Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Sedimentologie et de Geochimie de la Surface.

A. Probst, E. Dambrine, D. Viville, and B. Fritz.

Journal of Hydrology JHYDA7, Vol. 116, No. 1/4, p 101-124, August 1990. 8 fig, 7 tab, 36 ref.

Descriptors: "Acid rain, "Acid rain effects, "Air pollution effects, "Forest hydrology, "Forest watersheds, "France, "Geochemistry, "Path of pollutants, "Rainfall-runoff relationships, "Vosges Mountains, "Water chemistry, Acidification, Ion transport, Nitrogen, Precipitation, Springs, Spruce trees, Streams, Sulfur, Throughfall, Weathering.

The characteristics of surface and soil waters draining an old declining spruce stand, and their chemical behavior under acid input influence within a small catchment are described using open field precipitation, throughfalls, soil solutions, and spring and streamwater data. Precipitation is characterized by a rather low pH, resulting from a moderate global pollution climate. However, pollution peaks associated with easterly winds cause, during winter and spring, a strong increase of pollutant concentrations in open field precipitation and throughfall waters. Inputs of protons, sulfur and nitrogen, which originate mainly from dry and occult deposition, are approximately 1.8, 31, and 17 kg/hectare/year, respectively. Such injust strongly influence the inorganic mass transfer within the ecosystem. This influence results from the low base inputs have led to an acidification of soil solutions, The characteristics of surface and soil waters inputs have led to an acidification of soil solutions, an increase of their aluminum content and a decrease of exchangeable base cations, particularly for calcium; this process might be one of the fundamental causes of the deficiencies which characterize the forest decline phenomenon. In the regolith, the acid inputs strongly enhance silicate mineral weathering. However, stream waters and spring waters are not yet acidified owing to the neutralization of acid inputs by weathering in the regolith. Nevertheless, streamwater chemistry is dominated by strong acid anions which are not characteristics of waters draining bedrock in pristine areas. (Korn-PTT) inputs have led to an acidification of soil solutions tine areas. (Korn-PTT) W91-02741

EFFECTS OF VEGETATION TYPE ON THE BIOGEOCHEMISTRY OF SMALL CATCHMENTS (MONT LOZERE, FRANCE). Orleans Univ. (France). Lab. d'Hydrogeologie For primary bibliographic entry see Field 2K. W91-02742

LONGITUDINAL PATTERNS OF CONCENTRATION-DISCHARGE RELATIONSHIPS IN STREAM WATER DRAINING THE HUBBARD BROOK EXPERIMENTAL FOREST, NEW HAMPSHIRE.

Maine Univ. at Orono. Dept. of Plant and Soil

G. B. Lawrence, and C. T. Driscoll. Journal of Hydrology JHYDA7, Vol. 116, No. 1/ 4, p 147-165, August 1990. 8 fig, 2 tab, 22 ref. National Science Foundation Grant No. BSR-

Descriptors: \*Acid rain effects, \*Aluminum, \*Geochemistry, \*Ion transport, \*New Hampshire, \*Streams, Acidification, Dissolved organic carbon, Experimental basins, Hydrogen ion concentration, Neutralization, Silicon.

Longitudinal variations of concentration-discharge relationships and chemical fluxes were evaluated in two headwater streams at the Hubbard Brook Experimental Forest, New Hampshire. At high elevations changes in subsurface flow paths explained variations in H(+), inorganic Al and Si concentrations, whereas variations of dissolved organic carbon concentration were inconsistent with this mechanism. Flow responses of middle and low elevation subcatchments were influenced by variable contributions of hydrologic source areas and the elevational concentration gradient which exists in these catchments, but in most cases were not in these catchments, but in most cases were not in these catchments, but in most cases were not consistent with responses predicted by changes in flow paths. Spatial patterns of chemical fluxes indicate that, in general, catchment neutralization processes increased in effectiveness in the downslope direction. However, this pattern can be interpreted by exceedery tributaries both enhancement rupted by secondary tributaries, both ephemeral and persistent, which originate in variable source

areas that contribute acidic surface runoff during high flow conditions. Current models of catchment acidification need to incorporate spatial variations of biogeochemical processes and flow responses to improve predictions of short-term variations in surface water chemistry. (Author's abstract)

HYDROGEOCHEMICAL VARIATIONS IN HAFREN FOREST STREAM WATERS, MID-WALES

Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 4C. W91-02745

PRELIMINARY ANALYSIS OF WATER AND SOLUTE MOVEMENT BENEATH A CONIF-EROUS HILLSLOPE IN MID-WALES, U. K. Polytechnic South West, Plymouth (England). Dept. of Geographical Sciences. For primary bibliographic entry see Field 2E. W91-02746

HYDROLOGICAL AND HYDROCHEMICAL FLUXES THROUGH VEGETATION AND SOIL IN THE ALLT A'MHARCAIDH, WESTERN CAIRNGORMS, SCOTLAND: THEIR EFFECT ON STREAMWATER QUALITY. Macauluy Land Use Research Inst., Aberdeen (Scotland).

(Scottann), R. C. Ferrier, T. A. B. Walker, R. Harriman, J. D. Miller, and H. A. Anderson. Journal of Hydrology JHYDA7, Vol. 116, No. 1/4, p 251-266, August 1990. 9 fig, 2 tab, 18 ref.

Descriptors: \*Acid rain effects, \*Acidification, \*Cairngorm Mountains, \*Geochemistry, \*Scotland, \*Soil water, \*Soil-water-plant relationships, \*Water chemistry, \*Water quality, Air pollution effects, Base flow, Neutralization, Nitrogen, Soil chemistry, Streams, Sulfates, Vegetation effects.

A detailed investigation of the hydrochemical alteration of input water by vegetation and soils was undertaken in an upland catchment in the Cairngorm Mountain region of Scotland. The composition of the catchment outflow water reflects the hydrological routing of water through different soil horizons and the importance of long residence time water. There is uptake of nitrogen and neutralization of incoming anthropogenic acidity by time water. Inere is uptake of nitrogen and neu-tralization of incoming anthropogenic acidity by the vegetation, and sulfate adsorption in the miner-al soils. Streamwater quality is dominated by the contribution of long residence time water, especial-ly during base flow. Sulfate retention and cation release are the major neutralization mechanisms buffering outflow chemistry at this site. (Author's W91-02749

SHORT-TERM IONIC RESPONSES AS INDI-CATORS OF HYDROCHEMICAL PROCESSES IN THE ALLT A'MHARCAIDH CATCHMENT, WESTERN CAIRNGORMS, SCOTLAND. Freshwater Fisheries Lab., Pitlochry (Scotland). R. Harriman, E. Gillespie, D. King, A. W. Watt,

and A. F. G. Christie.

Journal of Hydrology JHYDA7, Vol. 116, No. 1/ 4, p 267-285, August 1990. 10 fig, 1 tab, 12 ref.

Descriptors: \*Acid rain effects, \*Acidification, \*Cairngorm Mountains, \*Geochemistry, \*Ion transport, \*Scotland, \*Water chemistry, Alkalinity, Flow profiles, High flow, Hydrographs, Hydrologic data, Low flow, Organic compounds, Streamflow, Sulfates.

An attempt to identify chemical controls in a transitional catchment in the Cairngorm region of Scotland was made using data from two distinct sampling regimes. Annual mean data from spot sampling regimes. Annual mean data from spot samples provided general information on alkalinity sources and acidification status, and flow/ion rela-tionships suggested a three-phase chemical re-sponse within the flow profile. Alkalinity and or-ganics appeared to show the greatest response to flow and sulfate the smallest. Information collected from time series sampling showed significant dif-

#### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 5B-Sources Of Pollution

ferences in the chemical response on the rising limb of the hydrograph compared with that on the falling limb, particularly for pH and alkalinity. In the first, low flow, response phase, the chemical changes are attributed to a simple dilution process with little or no influence form surface soil hori-zons. During the second and more complex interzons. During the second and more complex inter-mediate flow phase, the chemical response is com-patible with wetting and mixing processes in the soil horizons resulting in a more variable relation-ship between flow and pH/alkalinity. The delayed return of alkalinity, base cations and organics, during flow recession, to pre-event levels, indicates a reservoir of acid/organic-rich water which, until a reservoir of actor/organic-nen water which, until depleted, contributes a major fraction of the output water. In the third, high-flow phase, a state of chemical equilibrium appears with little or no change in ion concentrations for large changes in flow. This insensitivity reflects a relatively saturated system with establishment of major hydrological pathways which produce water of a similar chemistry. (Author's abstract)

EFFECT OF CLEARFELLING A SITKA SPRUCE (PICEA SITCHENSIS) PLANTATION ON SOLUTE CONCENTRATIONS IN DRAIN-

ON SOLUTE CONCESSAND.

AGE WATER.
Institute of Terrestrial Ecology, Grange over Sands (England). Merlewood Research Station.
For primary bibliographic entry see Field 4C.

GEOCHEMICAL CONTROL OF ALUMINIUM CONCENTRATIONS IN ACIDIFIED SURFACE

WATERS.
Oslo Univ. (Norway). Dept. of Chemistry.
H. M. Seip, S. Andersen, and A. Henriksen.
Journal of Hydrology JHYDA7, Vol. 116, No. 1/
4, p 299-305, August 1990. 4 fig. 21 ref.

Descriptors: \*Acid rain effects, \*Acidic water, \*Acidification, \*Aluminum, \*Geochemistry, \*Groundwater chemistry, \*Lakes, \*Soil chemistry, \*Solute transport, \*Streams, \*Surface-groundwater relations, \*Water chemistry, Equilibrium, Geomorphology, Hydrogen ion concentration, Ion transport, Kinetics, Model studies, Norway, Vegetation effects.

The relationship between concentrations of aluminum and hydrogen ions in surface waters was investigated on the basis of various studies, includinvestigated on the basis of various studies, including a regional survey of more than a thousand Norwegian lakes. It was concluded that equilibrium with a single aluminum hydroxide phase cannot account for observed aluminum concentrations and that water pathways play an important role in determining the concentrations in lake and stream water. Three interactive aspects of these factors were identified: (1) hydrological phenomena which control the proportions of waters entering the lake or stream from the upper soil zone (fest night) acidic), from the lower soil zone (less acidic and higher in inorganic aluminum content), and from deeper zones such as groundwater areas (even less acidic waters that are low in inorganic aluminum); (2) individual chemical signatures—differing from site to site in response to mineralogical, fering from site to site in response to mineralogical. alumnum); (2) individual chemical signatures—dif-fering from site to site in response to mineralogical, geomorphological, and vegetational factors—of these soil water and groundwater components; (3) non-equilibrium kinetic processes which control alumnum mobilization and precipitation. What-ever their relative influence, it is clear that any attempt to model regional water acidification must take these factors into account. One of the major processes studied in acidification research which is still not accounted for and is still little understood. still not accounted for, and is still little understood, is the mechanism which mobilizes and precipitates aluminum in both soil and streams. (Korn-PTT) W91-02752

MODELLING STREAMWATER CHEMISTRY AS A MIXTURE OF SOILWATER END-MEM-BERS-A STEP TOWARDS SECOND-GENERA-TION ACIDIFICATION MODELS.

Senter for Industriforskning, Oslo (Norway). N. Christophersen, C. Neal, R. P. Hooper, R. D. Vogt, and S. Andersen. Journal of Hydrology JHYDA7, Vol. 116, No. 1/ 4, p 307-320, August 1990. 4 fig, 1 tab, 26 ref.

Descriptors: \*Acid rain effects, \*Acidification, \*Geochemistry, \*Model studies, \*Soil water, \*Streams, \*Water chemistry, Data analysis, Data collections, Data interpretation, Hydrologic models, Least squares method, Mixing, Norway, Prediction, Soil chemistry, Whales.

In present acidification models, soilwater characteristics, though modelled, are seldom checked against field observations. Given that such data are against field observations. Over that such data are now collected as part of many catchment studies, a technique is developed whereby stream water can be predicted as a mixture of the observed soilwater classes or end-members. Provided that a sufficient set of end-members has been identified, a least-squares technique can be used to estimate the con-tribution to the stream from each end-member, whenever streamwater samples have been taken. For two catchments, Birkenes in southern Norway and Plynlimon in Mid-Wales, the analysis indicates that the soilwater end-members observed to date that the soilwater end-members observed to date are insufficient to explain streamwater chemistry. However, properties of the missing soil waters have been identified, thus facilitating future field work. When an adequate set of soilwater end-members have been established, long-term predictions of changes in streamwater chemistry reduce to the problem of predicting the fate of each end-member. Thus, a separate hydrological submodel is not needed, since the mixing patterns are derived from the end-member analysis. (See also W91-02754) (Author's abstract)

MODELLING STREAMWATER CHEMISTRY AS A MIXTURE OF SOILWATER END-MEM-BERS-AN APPLICATION TO THE PANOLA MOUNTAIN CATCHMENT, GEORGIA, U. S. A. Geological Survey, Doraville, GA. sources Div.

SR. P. Hooper, N. Christophersen, and N. E. Peters. Journal of Hydrology JHYDA7, Vol. 116, No. 1/ 4, p 321-343, August 1990. 10 fig, 3 tab, 24 ref.

Descriptors: \*Acid rain effects, \*Acidification, \*Geochemistry, \*Georgia, \*Model studies, \*Soil water, \*Water chemistry, Alkalinity, Calcium, Data analysis, Data interpretation, End-member mixing analysis, Experimental basins, Hydro-graphs, Magnesium, Mixing, Prediction, Rainfall, Silica, Sodium, Soil chemistry, Solute transport, Streams, Sulfates

Streamwater chemistry at Panola Mountain research catchment, Georgia, is explained as a mix-ture of representative soilwater solutions that are considered to be temporally invariant to a first approximation. The selection of three end-mem-bers from all sampled soil waters is evaluated by comparing the observed and predicted stream-water concentrations of six solutes (alkalinity, sulwater concentrations of six solutes (alkalinity, sulfate, sodium, magnesium, calcium, and dissolved silica), which are assumed to mix conservatively, and by assessing the consistence of the implied hydrograph separation with the hydrological mechanisms that are believed to be operating in this catchment. The percentage of variation in the streamwater solute concentrations explained by the end-member mixing analysis (EMMA) ranges from 82 to >97%, and the hydrograph separation is, intuitively, physically reasonable. If the correct end-members have been identified, the streamwater chemical resonage to different levels of acidit denchemical response to different levels of acidic deposition can be predicted by examining the change in each end-member under different loads; no hy-drological model is required. If a traditional hydro-chemical model which is driven by rainfall quantidrological model is required. It a traditional nydro-chemical model, which is driven by rainfall quanti-ty and quality, is desired, this analysis provides an indication of the model structure that would be necessary to reproduce both streamwater and soil-water chemistry. (See also W91-02753) (Author's abstract) W91-02754

HYDROGRAPH SEPARATION USING CHEM-ICAL TECHNIQUES: AN APPLICATION TO CATCHMENTS IN MID-WALES. Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 2K.

W91-02755

METHOD FOR PREDICTING THE EXTREMES OF STREAM ACIDITY AND OTHER WATER QUALITY VARIABLES.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
A. J. Jakeman, P. G. Whitehead, A. Robson, A. Jenkins, and J. A. Taylor.

Jenkins, and J. A. Taylor.

Journal of Hydrology JHYDA7, Vol. 116, No. 1/
4, p 375-390, August 1990. 7 fig, 4 tab, 21 ref.

Descriptors: \*Acid rain effects, \*Acid streams, \*Geochemistry, \*Streams, \*Water quality, Acidification, Acidity, MAGIC model, Model studies, Prediction, Scotland, Statistical models, Water

A hybrid deterministic-statistical approach is pro-posed for modeling the extremes of water quality in catchments subjected to long-term acidification. In the area of acidification modeling, long-term models such as MAGIC (Model of Acidification of Groundwater In Catchments) have been devel-Groundwater In Catchments) have been developed to simulate long-term trends and have been applied to a wide range of catchments. The approach used in this study is based on process models describing the long-term variations in mean chemistry. Superimposed on these mean projections are distributions providing information on the extremes of water quality which are fitted to catchment data using maximum likelihood techniques. The approach is general and can be applied to the prediction of other water quality variables where samples can be regarded as belonging to a parametric probability distribution. A simple implementation of the approach using chemical data and a calibrated deterministic model for the Allt a Marcaidh catchment is used as an illustrative method. Data from the catchment was analyzed method. Data from the catchment was analyzed and a preliminary form for the distribution was chosen. The mean values produced by the MAGIC model were combined with this knowledge of the distribution and estimates of the ex-tremes were derived. The approach is general and can be applied to the prediction of other water quality variables where samples can be regarded as belonging to a parametric probability distribution. (Korn-PTT) W91-02757

TOWARDS DEVELOPING A NEW SHORT-TERM MODEL FOR THE BIRKENES CATCH-MENT-LESSONS LEARNED.

Norges Vassdrags- og Elektrisitetsvesen, Oslo. For primary bibliographic entry see Field 2K. W91\_02759

REGIONAL MODEL OF ACIDIFICATION IN

Institute of Hydrology, Wallingford (England).
A. Jenkins, P. G. Whitehead, T. J. Musgrove, and Journal of Hydrology JHYDA7, Vol. 116, No. 1/ 4, p 403-406, August 1990.

Descriptors: \*Acid rain effects, \*Acidification, \*Model studies, \*Wales, \*Water quality, \*Water quality trends, Air pollution control, Hydrogen ion concentration, Lakes, MAGIC model, Monte Carlo method, Streams.

A regional assessment of streamwater quality in Wales is presented which reconstructs the historical trend for acidification and predicts the effect of cal trend for acidification and predicts the effect of several pollutant deposition reduction policies, using the Model of Acidification of Groundwater in Catchments (MAGIC). The regional methodology used is a two-stage coupling of Monte Carlo simulations with a calibration procedure designed to produce a coarse fit to the joint distribution of the key streamwater quality variables. The regional model is based on data from the Welsh Water Authority Survey of 1983-1984 during which streams and lakes were sampled weekly for one year. The modeling results reveal a significant streams and lakes were sampled weekly for one year. The modeling results reveal a significant decline of water quality across the region since industrialization. The model indicates that 40% of the streams and lakes within the region have suf-

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fered a decline of mean annual pH of >0.5 pH units. Predictions indicate that a 30% reduction of deposition would maintain present-day stream quality levels. Reductions of the order of 60% are required to ensure a significant recovery at most sites across the region. (Author's abstract) W91-02759

DEGRADATION OF VINYL ACETATE BY SOIL, SEWAGE, SLUDGE, AND THE NEWLY ISOLATED AEROBIC BACTERIUM V2.

Bayreuth Univ. (Germany, F.R.). Lehrstuhl fuer Mikrobiologie.

For primary bibliographic entry see Field 5D. W91-02769

REMOBILIZATION OF TOXIC HEAVY METALS ADSORBED TO BACTERIAL WALL-CLAY COMPOSITES.

Guelph Univ. (Ontario). Dept. of Microbiology. C. A. Flemming, F. G. Ferris, T. J. Beveridge, and G. W. Bailey.

Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 10, p 3191-3203, October 1990. 7 fig, 4 tab, 46 ref. EPA Grant CR813605-01-

Descriptors: \*Bacterial physiology, \*Clays, \*Heavy metals, \*Path of pollutants, \*Soil chemistry, Biochemistry, Chemical analysis, Chromium, Copper, Fate of pollutants, Geochemistry, Industrialization, Leaching, Organic matter, Silver, Toxicity, Urbanization.

Rapid industrialization and urbanization have caused elevated levels of toxic heavy metals to enter the biosphere. Significant quantities of silver, copper, and chromium were bound to isolated Bacillus subtilis 168 walls, Escherichia coli K-12 envelopes, kaolinite and smectite clays, and the corresponding organic material-clay aggregates (1:1, wt/wt). These sorbed metals were leached with strict acid calcium nitrate EDTA fulsion. with nitric acid, calcium nitrate, EDTA, fulvic acid, and lysozyme at several concentrations over acid, and lysozyme at several concentrations over 48 h at room temperature. The remobilization of the sorbed metals depended on the physical properties of the organic and clay surfaces and on the character and concentration of the leaching agents. In general, the remobilization of the metals was chromium < silver < copper. Chromium was very stable in the wall, clay, and composite systems; pH 3.0, 500 microM EDTA, 120-ppm (mg/ very state in the walt, casy, and composite systems; pH 3.0, 500 microM EDTA, 120-ppm (mg/L) fulvic acid, and 160-ppm calcium remobilized less than 32% of sorbed chromium. Silver (45 to 87%) and copper (up to 100%) were readily removed by these agents. Although each leaching agent was effective at mobilizing certain metals, elevated calcium or acidic pH produced the great-set overall mobility. The organic chelators were less effective. Lysozyme digestion of Bacillus walls remobilized copper from walls and copper-wall-kaolinite composites, but silver, chromium, and smectite partially inhibited enzyme activity, and the metals remained insoluble. The extent of metal remobilization was not always dependent on increasing concentrations of leaching agents. Sometimes the organic material-clay composites reacted in a manner distinctly different from that of their individual components. The particle size of the deposited metal may account for some of the stability changes; those metals that formed large, compact aggregates as seen by transmission elecbility changes; those metals that formed large, compact aggregates as seen by transmission elec-tron microscopy were less likely to be remobilized. Remobilization of toxic heavy metals in sediments, soils, and the vadose zone is a complicated issue, with predictions based on single inorganic or or-ganic component systems being too simplistic. (Au-thor's abstract) W91-02771

PATHOGENIC MARINE VIBRIO SPECIES IN SELECTED NOVA SCOTIAN RECREATIONAL COASTAL WATERS.

Dalhousie Univ., Halifax (Nova Scotia). Faculty of A. Badley, B. Phillips, D. J. M. Haldane, and M. T. Dalton.

Canadian Journal of Public Health CJPEA4, Vol. 81, No. 4, p 263-267, 1990. 2 fig, 3 tab, 11 ref.

Descriptors: \*Coastal waters, \*Nova Scotia, \*Path of pollutants, \*Recreation, \*Vibrio, \*Water pollu-tion effects, Coliforms, Estuaries, Fecal pollution, Marine bacteria, Mollusks, Pathogens, Public health. Water birds

Seven heavily frequented coastal recreation sites serving metropolitan Halifax and Dartmouth were serving metropolitan riamax and Dartmouth were investigated to determine the numbers and species of pathogenic marine vibrios (PMV) present. Sea-water, mussels and sea gull feces were cultured using quantitative methods and the effects of temperature and fecal pollution noted. Emergency rooms serving the sites under surveillance were monitored for PMV-related infections. All 11 recmonitored for PMV-related infections. All 11 rec-ognized species of PMV were recovered from the seven sites. Estuarine sites yielded a greater variety of species and greater numbers of PMV than non-estuarine sites. Culture of hand washings after immersion in seawater did not demonstrate contami-nation of skin by PMV. No cases of PMV infection in the seven surveillance sites were demonstrated. PMV contamination of marine recreational waters does not frequently result in superficial infections. (Author's abstract) W91-02780

OUTBREAK OF CAMPYLOBACTER ENTERI-TIS ASSOCIATED WITH A COMMUNITY

Centre Hospitalier Regional de la Beauce, Beauce-ville East (Quebec). Dept. de Sante Communau-

For primary bibliographic entry see Field 5C. W91-02781

POLYCHLORINATED BIPHENYLS PARTI-TIONING IN WATERS FROM RIVER, FILTRA-TION PLANT AND WASTEWATER PLANT: THE CASE FOR PARIS (FRANCE).

Paris-6 Univ. (France). Inst. d'Hydrologie et de Climatologie.

M. Chevreuil, L. Granier, A. Chesterikoff, and R.

Water Research WATRAG, Vol. 24, No. 11, p 1325-1333, November 1990. 8 fig,1 tab, 25 ref.

Descriptors: \*France, \*Paris, \*Path of pollutants, \*Polychlorinated biphenyls, \*Wastewater analysis, \*Water analysis, \*Water pollution sources, \*Water treatment, Drinking water, Organic carbon, Partition coefficient, Seine River, Suspended matter, Wastewater, Water pollution.

The partitioning of PCBs between the aqueous and particulate phases was studied from January to December 1987 in the Seine river at Paris, as well as the quality of the drinking water produced in the Orly plant. The concentrations in the influent and the effluent of the wastewater plant of Acheres were also measured. Mean concentration in the Seine river at Paris was 115 ng/L in 1986 and 130 ng/L at Orly (upstream from Paris) in 1987, which corresponds to the heavily polluted class of the World Health Organization (WHO). Evolution of PCB concentration and speciation in waters were studied following the hydrological cycle, the suspended matter content, its mineralogy, and particulate organic carbon content. In contrast to acceptadopinion, about three quarters of PCBs (73%) in late organic carbon content. In contrast to accepted opinion, about three quarters of PCBs (73%) in the Seine were carried by the aqueous phase, with no notable influence of the hydrological cycles suspended matters were insufficient (25 mg/L mean value) to adsorb the majority of the PCBs and their adsorption capacity varied inversely with their concentration. Therefore 67% of the PCBs of their concentration. Therefore 61% of the PCBs of the source water were not retained by the treat-ment plant, and the mean concentration of the drinking water was 79 ng/L. However, in most samples the concentration of PCBs was below the 100 ng/L norm of the European Economic Community. In own of the European Economic Colinian munity. In wastewaters the proportion of particulate FCBs was only 55%, probably due to their dissolution in greases and oils. The removal rate varied from 18 to 83% (mean 54%). Mean concentrations were 650 m wastewaters and 280 ng/L ate the outlet of the secondary settling basin. The annual estimated flux was 95 mg per capita. (Author's abstract) W91-02786

PROBABILITY MODEL FOR ACID RAIN DATA.

Canada Centre for Inland Waters, Burlington (On-

Water Research WATRAG, Vol. 24, No. 11, p 1335-1339, November 1990. 10 fig, 2 tab, 6 ref.

Descriptors: \*Acid rain, \*Acid rain effects, \*Alkalinity, \*Model studies, \*Probability distribution, Box-Cox Power Transformation, Color, Data collections, Hydrogen ion concentration, Lognormal distribution.

A probability model to represent lake alkalinity distributions based on the Box-Cox power transformations and covering the family of lognormal distributions was developed. The adequacy of the lognormal distribution was assessed by testing the significance of a single parameter in the proposed significance of a single parameter in the proposed model. It was shown that the three-parameter log-normal does not fit the majority of data sets from Eastern Canada. The pH-alkalinity relationship developed by Small and Sutton was previously used to yield a class of probability models representing the derived distributions for pH. The distributional model developed in this study allows more flexibility and extends the scope of applications to a wider class of distributions than what has been available. Everthermore, when the pH.Alk elastionship does Furthermore, when the pH-Alk relationship does not hold for a particular data set, the data set (if possible) may be divided into groups so that those groups for which the pH-Alk relationship is adequate are identified. This was illustrated by divid-ing the data from Nova Scotia into two groups according to water color. The results indicate an improved agreement between the pH-Alk relationship and the observations when water color is =/
< 30 Hazen units. (White-Reimer-PTT)
W91-02787

USE OF KINETIC BIOASSAY PROCEDURE TO ESTIMATE SULFATE AND CYSTEINE CONCENTRATIONS IN SEDIMENT.

Portland State Univ., OR. Environmental Sciences and Resources.

For primary bibliographic entry see Field 2H. W91-02796

ACCUMULATION FROM WATER AND DE-PURATION OF 110MAG BY A FRESHWATER FISH, SALMO TRUTTA L. CEA Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance (France). Lab. de Radioe-cologie des Eaux Continentales. J. Garnier, J. P. Baudin, and L. Foulquier. Water Research WATRAG, Vol. 24, No. 11, p 1407-1414, November 1990. 2 fig, 5 tab, 42 ref.

Descriptors: \*Bioaccumulation, \*Fish physiology, \*Nuclear reactors, \*Path of pollutants, \*Radioac-tive wastes, \*Silver, \*Trout, Kinetics, Liver, Ra-dionuclides, Tissues, Tracers.

The radioactive isotope 110mAg, which contrib-utes to total gamma radioactivity in low-level liquid wastes from some pressurized-water nuclear reactors, has been detected in fish living in the reactors, has been detected in fish living in the zones affected by waste discharges from such facilities. Accumulation kinetics were followed on a group of 20 brown trout maintained for 85 days in spring water contaminated with 30 Bq/ml of 110mAg. Because of a very significant radionuclide adsorption on all available surfaces, and in order to allow investigation of uptake under chronic exposure, the contaminated water was completely renewed three times a week. The development of radionuclide concentration in the trout followed slow uptake kinetics; the maximum contamination level would not be reached until about 900 days of exposure. The concentration factor, calculated from the ratio of the integrals of the curves representing the radionuclide concenthe curves representing the radionuclide concer-tration variations in the unfiltered water and in th tration variations in the unfiltered water and in the fish, reached a maximum value of 9 (w/w). At the end of the 57-day exposure phase, the 110mAg organotropism, investigated on 10 individuals, showed a very high concentration in the liver, amounting to 70% of the total radioactivity in the fish. Immediately following the accumulation

#### Group 5B-Sources Of Pollution

period (57 days), the remaining specimens were placed in non-radioactive water. After 28 days, their radioactivity level and the 110mAg distribu-tion in the tissues were the same as at the end of the uptake phase. (White-Reimer-PTT) W91-02798

HYDROLOGIC HYDROCHEMICAL CHARAC-TERIZATION OF TEXAS FRIO FORMATION USED FOR DEEP-WELL INJECTION OF CHEMICAL WASTES,

Texas Univ., Austin. Bureau of Economic Geolo-

gy. C. W. Kreitler, M. S. Akhter, and A. C. A

Environmental Geology and Water Sciences EGWSEI, Vol. 16, No. 2, p 107-120, 1990. 15 fig,

Descriptors: \*Groundwater movement. \*Groundwater pollution, \*Hazardous waste disposal, \*Injection wells, \*Path of pollutants, \*Texas, \*Waste jection wells, "Path of poliutants," 1exs., "Waste disposal wells, Artesian pressure, Biodegradation, Brines, Groundwater recharge, Injection, Microbi-al degradation, Oil fields, Saline-freshwater inter-faces, Water chemistry.

Hydrologic hydrochemical investigations were conducted to determine the long-term fate of haz-ardous chemical waste disposed in the Texas Gulf ardous chemical waste disposed in the Texas Gulf Coast Tertiary Frio Formation by deep-well injection. Three hydrologic regimes exist within the Frio Formation: a shallow fresh to moderately saline water section in the upper 3000-4000 ft; an underlying 4000-5000 ft section with moderate to high salinities; and a deeper overpressured section with moderate to high salinities. The complexity of the hydrologic environment is enhanced due to extensive depressurization in the 4000-8000 ft depth interval, which presumably results from the estimated production of over 10 billion barrels of oil equivalent and associated brines from the Frio in the past 50 years. Because of the higher fluid density and general depressurization in the brine in the past 50 years. Because of the higher fluid density and general depressurization in the brine hydrostatic section, upward migration of these brines to shallow fresh groundwater should not occur. Depressured oil and gas fields, however, may become sinks for the injected chemical wastes. Water samples appear to be in approximate oxygen isotopic equilibrium with the rock matrix, suggesting that active recharge by continental waters is not occurring. In the northern Texas Gulf Coast region salt dome dissolution controls water chemistry. In the central and southern Frio Formation, brines from the deeper geopressured section may be leaking into the hydrostatic section. The lack of organic acids and the alteration of Frio oils from samples collected from depths shallower than approximately 7000 ft suggest microbial degradation of organic material. This has useful implications for degradation of injected chemical wastes and needs to be investigated further. (Author's

GAMMA EMITTERS IN HONG KONG

Hong Kong Polytechnic, Kowloon. Dept. of Ap-

plied Physics. L. Shun-Yin, M. Chung-Keung, N. Wai-Kwok,

and A. Shui-Chun.
Environmental Geology and Water Sciences
EGWSEI, Vol. 16, No. 2, p 129-131, 1990. 3 tab, 1

Descriptors: \*Baseline studies, \*Gamma radiation, Groundwater pollution, "Hong Kong, "Nuclear powerplants, "Path of pollutants, "Radioactive wastes, "Water pollution sources, Drinking water, Groundwater, Radioactivity effects, Reservoirs, Rivers, Seawater, Spectral analysis.

Radioactivity in water originates from natural and artificial sources. The development of a nuclear powerplant near Hong Kong necessitates that attention be given to formulating techniques to assess the possible resultant environmental radioactive contamination. Water samples collected from various sites in Hong Kong in the spring and summer of 1987, representing seawater, river water, reservoir water, drinking water, and underground

water were studied through gamma-ray spectral analysis. Only gamma emitters in the U238 and Th232 series and K40 were detected. No fission product was detected with specific activity above 0.1 Bq/kg. The data could be the baseline for future monitoring of the radioactivity released from a nuclear plant being built at a 50-km distance from Hong Kong. The variation of detected specific activities may be due to geological differences and the effect of plants. (Author's abstract) (Fish-PTT) W91-02816

TRANSFORMATION OF MONOAROMATIC HYDROCARBONS TO ORGANIC ACIDS IN ANOXIC GROUNDWATER ENVIRONMENT. Geological Survey, Reston, VA. I. M. Cozzarelli, R. P. Eganhouse, and M. J. Baedesker.

Baedecker.

Environmental Geology and Water Sciences EGWSEI, Vol. 16, No. 2, p 135-141, 1990. 4 fig, 21

Descriptors: \*Benzenes. \*Biodegradation. \*Bio-

pollution, \*Hydrocarbons, \*Oil spills, \*Organic compounds, Anoxic conditions, Organic acids.

The transformation of benzene and a series of alkylbenzenes was studied in anoxic groundwater any theorems was studied in anoxic groundwater of a shallow glacial-outwash aquifer near Bemidji, Minnesota. Monoaromatic hydrocarbons, the most water-soluble components of crude oil, were trans-ported downgradient of an oil spill, forming a plume of contaminated groundwater. Organic acids that were not original components of the oil were identified in the anoxic groundwater. The highest concentrations of these oxidized organic compounds were found in the anoxic plume where a decrease in concentrations of structurally related alkylbenzenes was observed. These results suggest that biological transformation of benzene and al-kylbenzenes to organic acid intermediates may be an important attenuation process in anoxic environ-ments. The transformation of a complex mixture of hydrocarbons to a series of corresponding oxida-tion products in an anoxic subsurface environment provides new insight into in situ anaerobic degra-dation processes. (Author's abstract)
W91-02818

ESTIMATION OF THE CONTRIBUTION OF THE SULFATE ION TO RAINWATER ACIDI-

Kanazawa Univ. (Japan). Faculty of Technology. E. Hirai, M. Miyazaki, T. Chohji, M. Kitamura, and N. Okubo.

Environmental Technology (Letters) ETLEDB, Vol. 11, No. 8, p 757-764, 1990. 7 fig, 10 ref.

Descriptors: \*Acid rain, \*Instrumentation, \*Mete-Descriptors: "Acid rain, "Instrumentation, "Meteorological data, "Sulfates, "Water pollution sources, Anions, Atomic absorption spectrophotometry, Chlorides, Hydrogen ion concentration, Ion exchange chromatography, Ion-selective electrodes, Japan, Nitrates."

new method to estimate the contribution of alfate to acidity in rainwater has been developed. sulfate to acidity in rainwater has been developed. Rainwater samples were analyzed for pH, NH4(+), SO4(-2), NO3(-), Cl(-), Ca(+2), Mg(+2), Na(+), and K(+). Analytical methods were as follows: pH was determined by an ion electrode probe; NH4(+) by an indophenol method; anion by ion chromatography; and metal-lic cations by atomic absorption spectrophotometry. The application of the method was demonstrated using rainwater data representing four local strated using rainwater data representing four local strated using rainwater data representing four local weather configurations collected at Kanazawa, an area of low industrial activity on the Japan Sea side of Japan. Contribution percentages of the sul-fate ion, the main contributor, to acidity in rainwater of a pH between 4.0 and 4.6 were approximately 70% during non-winter weather, and about 85% during winter. Contribution ratios of nitrate and chloride ions, which are expected to account for the remaining acidity, could not be determined with the same accuracy, because the relationship of those ions with the total cation concentration is not as simple as that of the sulfate ion. Results were also compared to estimates based on the wide-

spread method of using excess sulfate (non-seasalt-derived sulfate) for the estimation of acidity. An estimation of the contribution of these anions will soon be made available, and it is expected that their contribution ratios will also prove valuable for the analysis of acid rain phenomena. (Fish-W91-02827

CHEMICAL CONSTITUENTS OF PRECIPITA-TION AND THEIR ROLE IN DETERMINING ITS ACIDITY IN BOMBAY.

Indian Inst. of Tech., Bombay. Centre for Environmental Science and Engineering.
V. K. Sharma, P. P. Joshi, and R. S. Patil. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 8, p 777-784, 1990. 1 fig, 6 tab, 13 ref.

Descriptors: "Acid rain, "Acid rain effects, "Air pollution, "Hydrogen ion concentration, "India, "Water pollution sources, Aerosols, Ammonia, Bombay, Chemical analysis, Chlorides, Nitrates, Nitric acid, Physical analysis, Seawater, Sulfates, Sulfuric acid

Acidity of precipitation, especially for industrialized regions, has been the subject of concern and research in recent times. Many studies in western countries have reported that acid deposition is increasing and this is mainly due to H(+) ions associated with the anions SO4(-), NO3(-), and Cl(-) which are generated primarily from anthropogenic emissions. Physical and chemical analysis of precipitation in Bombay, India, was conducted at two sites. The samples were analyzed for 12 physical and chemical constituents. It was observed that HNO3, H2SO4, and HCl were responsible for lowering the pH but due to high emissions of ammonia there was a neutralizing effect. The rain was found to be mostly alkaline in nature. The considerable emission of NH3 in the atmosphere causes a reaction to form (NH4)2SO4 which has a neutralizing effect. Calculations of sea sait ratios neutralizing effect. Calculations of sea salt ratios and ionic balance of aerosols indicate the significant contribution from continental and anthropo-genic sources. (Fish-PTT) W91-02829

SOURCES AND SINKS OF FORMIC, ACETIC, AND PYRUVIC ACIDS OVER CENTRAL AMA-ZONIA. 2. WET SEASON.

National Aeronautics and Space Administration, Hampton, VA. Langley Research Center. R. W. Talbot, M. O. Andreae, H. Berresheim, D. J. Jacob, and K. M. Beecher.

Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 10, p 16,799-16,811, Sep-tember 10, 1990. 10 fig. 4 tab, 40 ref. NSF Grant Nos. NSF-ATM 8413153 and NSF-ATM 8858074.

Descriptors: \*Acetic acid, \*Acid rain, \*Amazon River Basin, \*Atmospheric chemistry, \*Formic acid, \*Pyruvic acid, \*Seasonal variation, \*Water chemistry, Aerosols, Chemical interactions, Fluctuations, Forests, Model studies, Tropical regions.

The gas phase concentrations of formic (HCOOH), actic (CH3COOH), and pyruvic (CH3C(O)COOH) acids in the forestry canopy, boundary layer, and free troposphere over the central Amazon Basin during the April-May segment of the 1987 wet season have been determined. At 150-m altitude in the boundary layer the day-time average concentrations were 430 +/-225, 340 +/-155, and 25 +/-15 ppt for HCOOH, CH3COOH, and CH3C(O)COOH, respectively. These values were five-fold lower than those observed in the 1985 dry season. Concentrations The gas phase concentrations of formic (HCOOH), served in the 1985 dry season. Concentrations served in the 1985 dry season. Concentrations measured near the canopy top were not significantly different from boundary layer values (P = 0.10), while concentrations in the lower canopy were significantly less. Concentrations in the free troposphere (5 km) were lower than in the boundary layer and averaged 170 +/-40, a10 +/-40, and 15 +/-15 ppt for HCOOH, CH3COOH, and CH3C(OCOOH, especitively. Five-fold enhancements of CH3C(O)COOH concentrations were observed in convective sufflows at 5 to 6 km altiserved in convective outflows at 5 to 6 km alti-tudes. Aerosol carboxylate concentrations were usually below the detection limits of 5-10 ppt.

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Preliminary branch enclosure measurements indicated significant direct emission of carboxylic acids by vegetation. A one dimensional photochemical model for the canopy and the boundary level was used to examine the contributions from various sources to the carboxylic acid budgets. Model results indicate that direct emissions from vegetation can account for most of the concentrations observed in the canopy. These emissions peak during the daytime hours. Direct emissions from vegetation can account for only a small fraction of the observed carboxylic acid concentrations in the boundary layer, suggesting a large contribution observed carooxylic acid concentrations in the boundary layer, suggesting a large contribution from atmospheric sources, appear to be too slow to explain the observed concentrations. Other atmos-pheric reactions, so far unidentified, could make a major contribution to the carboxylic acid budgets. (Author's abstract) W91-02838

ATMOSPHERIC SULFUR CYCLE OVER THE AMAZON BASIN, 2, WET SEASON, Florida State Univ., Tallahassee. Dept. of Ocean-

ography.

M. O. Andreae, H. Berresheim, H. Bingemer, D. J. Jacob, and B. L. Lewis.
Journal of Geophysical Research (D) Atmospheres
JGRDE3, Vol. 95, No. 10, p 16,813-16,824, September 20, 1990. 10 fig, 3 tab, 57 ref. NASA
Tropospheric Chemistry Program Grant No.
NAG-1-588; NSF Grant Nos. ATM-8407137,
ATM-8413153, ATM-8858074.

Descriptors: \*Amazon River Basin, \*Atmospheric chemistry, \*Path of pollutants, \*Sulfur cycle, \*Water pollution sources, Aerosols, Canopy, For-ests, Model studies, Sulfates, Sulfides, Sulfur compounds, Tropical regions

The fluxes and concentrations of atmospheric sulfur species at ground level and from aircraft over the Amazon Basin during the 1987 wet season were determined, providing a comprehensive description of the sulfur cycle over a remote tropical region. The vertical profile of dimethyl sulfide (DMS) during the wet season was found to be very similar to that measured during the dry season, suggesting little seasonal variation in DMS fluxes. The concentrations of hydrogen sulfide (H2S) were almost an order of magnitude higher than those of DMS, which makes H2S the most important biogenic source species in the atmospheric sulfur cycle over the Amazon Basin. The flux of DMS at the top of the tree canopy was determined using the gradient-flux approach. The canopy was a source of DMS during the day, and a weak sink during the night. Measurements of sulfur gas emissions from soils, using the chamber method, showed very small fluxes, consistent with the hypothesis that the forest canopy is the major source of sulfur gases. The observed soil and canopy emission fluxes are similar to those measured in temperate regions. The concentrations of SO2 and sulfate aerosol in the wet season atmosphere were similar to dry season values. The sulfate concentration in rainwater, on the other hand, was lower by a factor of 5 during the wet season. Due to the higher precipitation rate the wet deposition flux of sulfate was not significantly different between the seasons. The measured fluxes and concentrations of DMS, H2S, and SO2 were consistent with a model sulfate was not significantly different between the seasons. The measured fluxes and concentrations of DMS, H2S, and SO2 were consistent with a model describing transport and chemistry of these sulfur species in the boundary layer. The concentration of aerosol and the sulfate deposition rate could only be explained by import of significant amounts of marine and anthropogenic sulfate aerosol into the Amazon Basin. (Author's abstract)

PRECIPITATION CHEMISTRY IN CENTRAL

AMAZONIA. Florida State Univ., Tallahassee. Dept. of Oceanography.
For primary bibliographic entry see Field 2B.
W91-02840

LEACHING OF PESTICIDES FROM TREATED TIMBERS-A SOURCE OF POLLUTION.

Journal of the Institution of Water and Environ-

mental Management JIWMEZ, Vol. 4, No. 4, p 330-334, August 1990. 3 fig. 4 tab, 3 ref.

Descriptors: \*Leaching, \*Pesticides, \*Preserva-tives, \*Saw mills, \*Water pollution sources, \*Wood preservatives, Dieldrin, Industrial wastewater, Lossie River, Pentachlorophenol.

Observations at a sawmill where two major spil-lages of preservative had led to pollution of the River Lossie indicated that bad timber treatment practices, together with minor spillages when prepractices, together with minor spillages when pre-servative was delivered to the premises, were con-tributing to the overall unsatisfactory state of the watercourse. Also, soil sampling at the saw mill, and laboratory trials, revealed that the storage of freshly treated timbers can be a significant source of pollution. In order to prevent contamination of water from these sources, recommendations were issued to the sawmill, and the company relocated issued to the sawmill, and the company relocated the timber treatment plant on a specially prepared self contained site to avoid pollution should further spillages occur. Remedial recommendations encompassed: (1) strict adherence to the preservative manufactures guidelines; (2) relocation of treatment area to a confined site; and (3) preventing future spillages. (Lantz-PTT) W91-02844

RECENT INVESTIGATION OF TOTAL CAR-BONATE IN THE BALTIC SEA: CHANGES FROM THE PAST AS A RESULT OF ACID

Goeteborg Univ./Chalmers Univ. of Technology (Sweden), Dept. of Analytical and Marine Chemis-

try.
M. Ohlson, and L. Anderson.
Marine Chemistry MRCHBD, Vol. 30, No. 1/3, p
259-267, 1990. 3 fig, 1 tab, 12 ref.

Descriptors: \*Acid rain effects, \*Baltic Sea, \*Carbonates, \*Gulf of Bothnia, \*Path of pollutants, Alkalinity, Calcium, Chemical analysis, Mixing,

In a plot of the concentration of either total alka-linity or calcium versus salinity in the Baltic Sea, two mixing lines are evident: one for the mixing of low alkalinity river water, from the Gulf of Bothnia, with Baltic Proper surface water, and one for the mixing of Baltic Proper surface water with the mixing of Battle Proper surface water with Kategatt water. The intercept at salinity = 0 for the Baltic-Kategatt mixing line gives the mean river concentration, which is compared with earli-er results of other workers. The earlier mean river concentrations are different for both calcium and concentrations are uniferent for our calcular autoral alkalinity, but the ratio is about the same (approximately 0.41). However, a 1986 investigation gave a significantly different ratio (0.691) as a result of both an increased calcium and a decreased total alkalinity concentration. Explanations for the differences in the mean river concentration are differences in the mean river concentration are offered, based on reactions in the drainage basins including the decay of organic matter, precipitation of acid rain, and dissolution of carbonate minerals. (Author's abstract)
W91-02833

HYDROCARBON POLLUTION IN PARTICLE-RICH WATERS (GULF OF FOS-SUR-MER): COMPARATIVE STUDY OF EXTRACTION PROCEDURES

Centre d'Oceanologie de Marseille (France). For primary bibliographic entry see Field 5A. W91-02854

FATE OF ALDICARB IN THE UNSATURATED ZONE BENEATH A CTITUS GROVE.
Florida Univ., Gainesville. Dept. of Soil Science.
A. G. Hornsby, P. S. C. Rao, and R. L. Jones.
Water Resources Research WRERAQ, Vol. 26,
No. 10, p 2287-2302, October 1990. 15 fig, 2 tab, 50
ref. Union Carbide Agricultural Company contract
81065-C.

Descriptors: \*Aldicarb, \*Citrus crops, \*Fate of pollutants, \*Florida, \*Path of pollutants, \*Pesticides, Drainage, Leaching, Root zone, Soil chemistry, Testing procedures.

A field study was conducted in a 1.6 ha citrus grove located in central Florida to evaluate transport and transformations of the nematicide aldicarb and its two metabolites (aldicarb sulfoxide and and its two metabolites (aldicarb sulfoxide and aldicarb sulfone) in the unsaturated zone over a 218-day period during 1984. Bromide leaching was also monitored to provide a tracer of water move-ment in this well-drained, deep, sandy soil. Aldi-carb and bromide were applied in 3-m wide treat-ment bands located midway between tree rows (7.62 m apart) and incorporated into the top 5 cm soil by disking. This application method resulted in extreme variability in solute concentrations across and within the treatment bands, which persisted at and within the treatment bands, which persisted at all depths even as the pesticide and bromide leached during the study period. Aldicarb, its metabolites (sulfoxide and sulfone), and bromide leached readily through the soil and moved past the 7.92 m depth by the last sampling date (218 days). Aldicarb dissipated rapidly (half-life <= 2 weeks), yielding aldicarb sulfoxide and aldicarb sulfoxe. Both of these compounds also dissipated but at a rate slower than that for aldicarb. The dissipation of total carbants residues under filed dissipation of total carbamate residues under field conditions was characterized by a half-life of about 69 days, which was in agreement with laboratory-derived values. On the basis of the findings of this study, it is suggested that although generic guide-lines are useful for studying the environmental fate ines are useful for studying the environmental rate of pesticides, rigid protocols should not be specified by regulatory agencies for these types of studies. Instead, a specific protocol must be developed (based on site characteristics, agricultural practices, and the chemical of interest) which can account for both extrinsic and intrinsic variability at each particular field site. (Author's abstract) W91-02859

EXPERIMENTAL INVESTIGATION OF VARI-ABLE DENSITY FLOW AND MIXING IN HO-MOGENEOUS AND HETEROGENEOUS MEDIA.

Ohio State Univ., Columbus. Dept. of Geology For primary bibliographic entry see Field 2F. W91-02862

ANALYTICAL SOLUTION FOR ONE-DIMEN-SIONAL TRANSPORT IN HETEROGENEOUS POROUS MEDIA.

California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 5F.

APPARENT DISPERSION IN TRANSIENT GROUNDWATER FLOW, Geological Survey, Reston, VA. For primary bibliographic entry see Field 2F. W91-02864

GAS MIGRATION IN DISCRETE FRACTURE NETWORKS.

Royal Inst. of Tech., Stockholm (Sweden). Dept. of Land and Water Resources. For primary bibliographic entry see Field 5E. W91-02871

UNCERTAINTY PROPAGATION WITH NU-MERICAL MODELS FOR FLOW AND TRANS-PORT IN THE UNSATURATED ZONE. Polytechnic Univ., Brooklyn, NY. Dept. of Civil and Environmental Engineering. For primary bibliographic entry see Field 2G. W91-02875

NUMERICAL SIMULATION OF SOLUTE TRANSPORT IN THREE-DIMENSIONAL, RANDOMLY HETEROGENEOUS POROUS

Lawrence Livermore National Lab., CA. Earth ciences Dept.

Sciences Dept.
A. F. B. Tompson, and L. W. Gelhar.
Water Resources Research WRERAQ, Vol. 26,
No. 10, p 2541-2562, October 1990. 12 fig, 2 tab, 57
ref. United States Nuclear Regulatory Commission

#### Group 5B-Sources Of Pollution

Contracts NRC-04-83-174 and NRC-04-88-074, National Science Foundation Grant ECE-8311786, ed States Department of Energy Contract W-

Descriptors: \*Groundwater movement, \*Mathematical models, \*Path of pollutants, \*Porous media, \*Soil porosity, \*Soil water, \*Solute transport, Advection, Dispersion, Flow rates, Heterogeneity, Hydraulic conductivity, Plumes.

Subsurface porous materials typically exhibit a Subsurface porous materials typically exhibit a large degree of natural variability in terms of their type and spatial distribution. A three-dimensional solute transport model has been developed to study detailed contaminant movements through large heterogeneous flow systems in porous media. The model is based upon a random walk particle method to treat multidimensional advection and dispersion processes in saturated or unsaturated media in a computationally efficient manner. The transport simulations are used to examine the large time and spatial effects of the variable flow field on developing solute plumes, and, in particular, to investigate the nature of the large-scale dispersive behavior. Numerical transport experiments were conducted using single realizations of random hy-draulic conductivity fields with three different degrees of heterogeneity. Experiments with different grees of heterogeneity. Experiments with different source locations were used to investigate preasymptotic and nonergodic effects that would appear as differences in plume evolution among the experiments. Spatial moments of the particle distributions in statistically isotropic saturated media compare favorably with stochastic theory predictions in terms of longitudinal advection and mixing, but differ markedly from predictions of transverse mixing. The simulations also demonstrate that significant nonergodic effects occur, as reflected in strong differences in the second strate that significant indiregouse effects occur, are reflected in strong differences in the second moment evolution curves among the individual experiments and as predicted from the ensemble stochastic theory. (Author's abstract)

ANALYTICAL TRAVELING WAVE SOLU-TIONS FOR TRANSPORT WITH NONLINEAR TIONS FOR TRANSPORT WITH NONLINEAR AND NONEQUILIBRIUM ADSORPTION. Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Plant Nutrition. For primary bibliographic entry see Field 2G. W91-02882

APPLICATION OF THE ARNOLDI ALGO-RITHM TO THE SOLUTION OF THE ADVEC-TION-DISPERSION EQUATION, Manitoba Univ., Winnipeg. Dept. of Geological Engineering.
A. D. Woodbury, W. S. Dunbar, and B. Nour-

Water Resources Research WRERAQ, Vol. 26, No. 10, p 2579-2590, October 1990. 11 fig, 5 tab, 38

Descriptors: \*Advection, \*Dispersion, \*Ground-water movement, \*Mathematical models, \*Path of pollutants, \*Plumes, \*Pollutants, \*Solute transport, Camp Borden Site, Differential equations, Finite

The solution to the finite element matrix differen-Ine solution to the finite element matrix differential equations resulting from the discretization of the contaminant transport equation is normally carried out by a finite difference approximation to the time derivative. The total computational effort in simulating a contaminant plume is then directly related to the number of unknowns and the number of time steps required to obtain accurate and stable solutions. An alternative method is the Arnoldi algorithm which uses orthogonal matrix transfor-mations to reduce the finite element equations to a mantons to reduce the finite element equations to a much smaller upper Hessenberg system of first-order differential equations. This new system can be solved by a standard Crank-Nicolson algorithm with very little computational effort. A matrix-vector multiplication is then used to obtain the original solution at desired time steps. The algo-rithm is used to simulate accurately the contaminant plumes for a strip source areal aquifer, a cross-sectional problem, and the Borden landfill in Ontario, Canada. The Arnoldi algorithm shows an

impressive 613% increase in speed over the conventional Crank-Nicolson scheme for the Borden landfill. The method affords an efficient means of solving large problems, particularly when time du-rations are long. (Author's abstract) W91-02883

STOCHASTIC ANALYSIS OF THE CONCEN-TRATION VARIABILITY IN A THREE-DI-MENSIONAL HETEROGENEOUS AQUIFER. Nationale Genossenschaft fuer die Lagerung Ra-dioaktiver Abfaelle. Baden (Switzerland). For primary bibliographic entry see Field 2F. W91-02884

METAL-ORGANIC ASSOCIATIONS IN SEDI-MENTS--I, COMPARISON OF UNPOLLUTED RECENT AND ANCIENT SEDIMENTS AND SEDIMENTS AFFECTED BY ANTHROPOGEN-IC POLLUTION.

Munich Univ. (Germany, F.R.). Mineralogisch-Petrographisches Inst.
A. V. Hirner, K. Kritsotakis, and H. J. Tobschall.
Applied Geochemistry APPGEY, Vol. 5, No. 4, p
491-505, July/August 1990. 2 fig, 4 tab, 89 ref.

Descriptors: \*Metals, \*Organic matter, \*Path of pollutants, \*Sediment contamination, Arsenic, Boron, Cadmium, Cobalt, Comparison studies, Copper, Humic acids, Kerogen, Lead, Manganese, Mangrove swamps, Mercury, Molybdenum, Nickel, Oil shale, Silver, Spectrometry, Trace elements, Vanadium, Wastewater pollution, Zinc.

The concentrations of 19 trace elements were determined by plasma emission spectrometry in organic fractions (organic solvent extractables, soluble humics, protokerogen and kerogen concentrates) separated from various recent and ancient sediments (Mangrove sediments, algal mats, oil shales, phosphorites) as well as sediments polluted by industrial metal emissions (Rhine River, Port Pirie smelter effluent). Often the organic constituents were found to be enriched in trace elements (especially B, V, Mn, Co, Ni, Cu, Zn, As, Mo, Ag, Cd, Sb, Hg, and Pb) up to more than three orders of magnitude compared to the bulk sediments, indicating the importance of organic substances with respect to transport and fixation trace elements with sediments. The formation of metalorganic associations was found to reflect the environment of deposition (marine to terrestrial) as The concentrations of 19 trace elements were deorganic associations was round to reflect the envi-ronment of deposition (marine to terrestrial) as well as diagenetic transformations (recent to an-cient). Against an unpolluted natural background, increasing metal pollution led to increasing metal uptake by organic substances (especially for B, Cr, Fe, Co, Cu, Zn, As, Cd, and Pb). (See also W91-02892) (Author's abstract)
W91-02891

INTEGRATED CHEMICAL AND BIOLOGICAL STUDY OF THE BIOAVAILABILITY OF METALS IN SEDIMENTS FROM TWO CONTAMINATED HARBOURS IN NEW BRUNS-

Environmental Protection Service, Dartmouth

H. S. Samant, K. G. Doe, and O. C. Vaidya. Science of the Total Environment STENDL, Vol. 96, No. 3, p 253-268, August 1990. 1 fig, 8 tab, 12

Descriptors: \*Bioavailability, \*Canada, \*Heavy metals, \*Path of pollutants, \*Sediment contamination, \*Water pollution effects, Bioaccumulation, Cadmium, Cobalt, Copper, Fate of pollutants, Geochemistry, Harbors, Iron, Lead, Manganese, Oxides, Strontium, Trace metals, Zinc.

Harbor sediments in Dalhousie and Belledune, New Brunswick, Canada, are known to be con-taminated with copper, zinc, lead, and cadmium. Relatively high concentrations of these metals in the resident organisms were reported from previ-ous surveys. Experiments were conducted in the laboratory to study partitioning and bioavailability of heavy metals present in the contaminated sediments. A procedure to extract metals sequentially from sediments was used to determine their distribution in various geochemical fractions. A com-

panion experiment was also set up to determine the bioavailability of trace metals from these sediments. Experimental data indicated that the metals associated with hydrous oxides of iron and manganese and the residual fraction carried the major burden of heavy metals in the sediment. Appreciable uptake of metals was observed to occur only from the Belledune sediment. Biota accumulated lead and cadmium to the greatest extent, with strontium, cobalt, and zinc taken up to a lesser degree as compared with control animals in uncondegree as compared with control animals in uncon-taminated sediments. Concern is directed to heavy metals associated with hydrous oxides of iron and manganese because changing environmental condi-tions can transfer these elements from the sedi-ments into the aqueous phase. (Author's abstract) W91-02931

MONITORING AND ASSESSMENT OF MER-CURY POLLUTION IN THE VICINITY OF A CHLORALKALI PLANT: I. DISTRIBUTION, AVAILABILITY AND GENOTOXICITY OF SEDIMENT MERCURY IN THE RUSHIKULYA ESTILABLY INDIA ESTUARY, INDIA.

ESTUARY, INDIA.
Berhampur Univ. (India). Dept. of Botany.
K. K. Panda, M. Lenka, and B. B. Panda.
Science of the Total Environment STENDL, Vol.
96, No. 3, p 281-296, August 1990. 5 fig. 5 tab, 26

Descriptors: \*Bioassay, \*Bioavailability, \*Estuarine sediments, \*Genotoxicity, \*India, \*Industrial wastewater, \*Mercury, \*Path of pollutants, \*Water pollution effects, Bioaccumulation, Biological magnification, Hydrogen ion concentration.

Roots, Sediment contamination.

Industrial effluent discharged into the Rushikulya, India, estuary from a chloralkali plant has been identified as the source of mercury which has polluted the estuary for the past two decades. Sediment samples taken from eight sites representing the effluent channel, effluent discharge point, and the course of the estuary, were analyzed for total mercury. The leachability of mercury from sediments was studied as a function of pH. Chemical extraction was used to assess bioavailability of mercury from the sediments. Further, sediment samples were bioassayed by the Allium micronucleus (MNC) assay. The endpoints measured were root length, root mercury (bioconcentrated mercury) and frequency of root meristematic cells with MNC. The mercury concentrations in sediment samples ranged from 1.6 to 192 mg/kg. The results indicated that pH was an important factor regulating the availability of mercury; the lower the pH the higher the availability of mercury; the lower the pH the highest the availability of mercury, the lower the pH the highest chandle extractants used, 0.05 M CaCl2 extractable mercury showed the highest correlation with the bioconcentrated mercury, emphasizing the fact that 0.05 M CaCl2 was the best predictor of bioavailable mercury form the sediment. Similarly, the frequency of root meristematic cells with MNC was highly correlated not only with bioconcentrated mercury, as evidenced by 0.05 M CaCl2 extractable mercury. The Allium MNC assay can assess mercury politution and takes into account the ble mercury, as evidenced by 0.05 M CaCl2 ex-tractable mercury. The Allium MNC assay can assess mercury pollution and takes into account the bioavailability of the metal. The overall assessment indicated that, although localized, the sediment of the estuary is contaminated with high concentra-tions of mercury with respect to both bioavailabi-lity and toxicity. (Author's abstract) W91-02932

ABSENCE OF CADMIUM IN THE BLOOD OF HORSES FED OATS GROWN ON MUNICIPAL SLUDGE-AMENDED SOIL.

For primary bibliographic entry see Field 5E. W91-02933

CONTAMINANT MIGRATION THROUGH FRACTURED TILL INTO AN UNDERLYING

AQUIFER. University of Western Ontario, London. Geotechnical Research Centre. R. K. Rowe, and J. R. Booker. Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 4, p 484-495, August 1990. 7 fig, 1 tab, 31

# Effects Of Pollution-Group 5C

ref, append. NSERC Grant No. A1007.

Descriptors: \*Aquifers, \*Geologic fractures, \*Glacial drift, \*Groundwater movement, \*Groundwater er pollution, \*Groundwater quality, \*Landfills, \*Mathematical models, \*Model studies, \*Path of pollutants, Computer models, Diffusion coefficient, Dispersivity, Effective porosity.

The potential impact on groundwater quality of contaminant migration from a landfill site, through a fractured till, and into an underlying aquifer was studied. A simple, semi-analytic technique for modeling contaminant transport through the fractured till was developed, including consideration of diffusion of contaminants from the fractures into the till matrix, sorption, and radioactive decay. The model also considered the finite mass of contaminant and dilution due the flow of groundwater in the aquifer. The model can be easily implement. taminant and dilution due the flow of groundwater in the aquifer. The model can be easily implementing of on a microcomputer. The model allowed examination of variations in fracture spacing, fracture opening size, thickness of the fractured zone, diffusion coefficient, dispersivity, effective porosity of the matrix, radioactive decay, Darcy velocity, thickness of the aquifer, distribution coefficient, and mass of the contaminant. A limited parametric study was made to illustrate the application of the theory, practical implications, and inter alia, examined the effects of uncertainty in fracture spacing, the thickness of the fractured till, and the effective porosity of the till matrix. (Author's abstract)

MIGRATION OF POLLUTANTS IN GROUND-WATER: IV. MODELING OF THE PUMPING OF CONTAMINANTS FROM FRACTURED

Vanderbilt Univ., Nashville, TN. Dept. of Chemis-

For primary bibliographic entry see Field 2F. W91-02945

ALUMINIUM DEPOSITION IN BONE AFTER CONTAMINATION OF DRINKING WATER

Saint George's Hospital Medical School, London (England). Dept. of Cellular and Molecular Sci-

For primary bibliographic entry see Field 5C. W91-02951

#### 5C. Effects Of Pollution

EVALUATION OF THE SEA URCHIN ECHIN-OMETRA IUCUNTER AS AN INDICATOR OF HEAVY-METAL CONTAMINATION IN CUBA (EVALUACION DEL ERIZO DE MAR ECHIN-OMETRA IUCUNTER COMO INDICATOR DE CONTAMINACION POR METALES PESADOS, CUBA).

Instituto de Investigaciones del Transporte, Havana (Cuba). Unidad de Proteccion Ambiental. For primary bibliographic entry see Field 5A. W91-02044

SUBLETHAL AND HISTOPATHOLOGICAL EFFECTS OF TRACE LEVELS OF TRIBUTYL-TIN FLUORIDE ON ADULT OYSTERS CRAS-SOSTREA GIGAS.

Institut Français de Recherche pour l'Exploitation de la Mer. Paris.

D. Chagot, C. Alzieu, J. Sanjuan, and H. Grizel. Aquatic Living Resources ALREEA, Vol. 3, No. 2, p 121-130, 1990. 19 fig, 1 tab, 26 ref.

Descriptors: \*Antifoulants, \*Organotin compounds, \*Oysters, \*Tributyltin fluoride, \*Water pollution effects, Aquaculture, Ecotoxicology, Tissue analysis, Toxicity.

Adult oysters (Crassostrea gigas) were exposed to environmental concentrations of tributyltin fluoride (2, 13.1 and 64.8 ng/L), for a period of 1 month, which included both an exposure and depuration phase. The results showed that the digestive gland is the primary target organ. Recoverable modifications were observed at the lowest concen-

tration. Limited necrosis was observed at the highest concentration and a longer exposure could have led to extensive and irreversible tissue lesions. Shell malformations (chambering) were observed during the depuration phase. Suggested safe tributyltin levels in mariculture waters should be < 2 ng/L. (King-PTT) W91-02045

EFFECTS OF HEAVY METALS ON EELS, ANGUILLA SP.

Perpignan Univ. (France). Lab. de Biologie Marine.

J. Brusle. Aquatic Living Resources ALREEA, Vol. 3, No. 2, p 131-141, 1990. 2 tab, 73 ref.

Descriptors: \*Bioindicators, \*Ecotoxicology, \*Eel, \*Heavy metals, \*Literature review, \*Water pollution effects, \*Water quality, Japan, Marine environment, Mercury, Sediment contamination, Tox-

About 60 papers and reports dealing with heavy metal contents in different eel species are reviewed in order to document various patterns of uptake, elimination and accumulation of the metals and to underline their detrimental effects such as lethality underline their detrimental effects such as lethality and histopathology. Two main toxicological topics are considered: observation on contaminant levels in eels taken from the wild (mainly from contaminated waters), and experimental studies under laboratory conditions. Eels are found to acquire heavy metals directly from the water, from the sediments or from their food. (Author's abstract)

RESPONSE AND RECOVERY OF BRAIN ACE-TYLCHOLINESTERASE ACTIVITY IN AT-LANTIC SALMON (SALMO SALAR) EXPOSED TO FENITROTHION.

Department of Fisheries and Oc (Newfoundland). Science Branch. For primary bibliographic entry see Field 5A. W91-02061

EFFECTS OF CALCIUM AND PH ON THE REPRODUCTIVE SUCCESS OF AMNICOLA LIMOSA (GASTROPODA).

Guelph Univ. (Ontario). School of Engineering.

M. A. Shaw, and G. L. Mackie.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 9, p 1694-1699, September 1990. 3 fig, 4 tab, 24 ref.

Descriptors: \*Acid rain effects. \*Acidic water. Descriptors: "Acid rain effects, "Acidic Water, "Calcium, "Gastropods, "Hydrogen ion concentra-tion, "Lake acidification, "Mollusks, "Reproduc-tion, "Water chemistry, "Water pollution effects, Buffer capacity, Embryonic growth stage, Inverte-brates, Laboratory methods, Limiting nutrients.

Field and laboratory experiments were designed to examine the relationship between water chemistry (especially pH and calcium) and the reproductive success of Amnicola limosa. Fecundity (number eggs/female) was positively correlated with lake buffering capacity (P = 0.002) in naturally occurring populations. Ther was a 66% reduction in fecundity in lakes over a pH range of 7.5 to 5.8. However, fecundity was higher than expected in a highly-coloured, low-pH lake. The number of juveniles produced per egg was not related to any water chemistry variable (multiple R-squared = 0.186). A laboratory experiment demonstrated that pH, and not calcium, was limiting embryonic development. All embryos held at pH 4.5 failed to hatch. Eggs held at pH 5.5 experienced reduced hatching success (P = 0.013) and delayed development (P<0.001) compared with those held at pH 6.5. Length of newly hatched snais did not differ significantly between treatments (P = 0.891). The ceitical calcium consertation serviced for extended for the control of the con Field and laboratory experiments were designed to o.5. Length of newly natched shalls did not differ significantly between treatments (P = 0.891). The critical calcium concentration required for embryonic development in laboratory incubation lay between 0.14 and 1.11 mg/L. This is well below the calcium concentration of acidifying lakes in south-central Ontario. (Author's abstract) W91-02064

PROTECTIVE ACTION OF IONS AGAINST CADMIUM TOXICITY TO YOUNG BUFO ARENARUM TADPOLES.

Universidad Nacional de Lujan (Argentina). Lab. of Ecophysiology.

C. V. Muino, L. Ferrari, and A. Salibian. Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 3, p 313-319, September 1990. 1 fig, 2 tab, 21 ref. Comision de Investigaciones Científicas Grant 7812/86.

Descriptors: \*Acute toxicity, \*Amphibians, \*Cadmium, \*Toads, \*Toxicology, \*Water pollution effects, Aquatic animals, Heavy metals, Inorganic ions, Ionic strength, Lethal limit.

The impact of Cd(II) on the response of tadpoles (Bufo arenarum) to solutions of varying ionic strength was investigated. At 0.5 and 1.0 mg/L of Cd(II) in ionic solutions, mortality was less than Cd(II) in ionic solutions, mortality was less than 10%; above these concentrations, toxicity showed an abrupt rise. The 96 h LC50 for tadpoles exposed to Cd(II) was 2.08 mg/L. In ion-free or non-ionic solutions, 1.0 mg/L Cd(II) caused 100% mortality within a few hours. The presence of 1.0 mg/L Cd(III) in solutions of varying ionic strength was not associated with changes in the water balance of the animals. The data indicate that inorganic ions have a protective action on the toxic effects of Cd(II). The cadmium toxicity may be interpreted as a secondary consequence of the known inhibitory effect on epithelial ATPases. (MacKeen-PTT) W91-02092

SUBLETHAL EFFECTS OF 2,2-DICHLORO-PROPIONIC ACID (DALAPON) ON FOSSARIA CUBENSIS, INTERMEDIATE HOST OF THE LIVER FLUKE, FASCIOLA HEPATICA.

Southern Univ., Baton Rouge, LA. Dept. of Biological Sciences.

F. A. Christian, and J. A. Thompson. Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 3, p 343-349, September 1990. 2 fig, 2 tab, 8 ref. NIH Grant RR 08025.

Descriptors: \*Animal parasites, \*Dalapon, \*Herbicides, \*Snails, \*Toxicology, \*Water pollution effects, Chronic toxicity, Dose-response relationships, Experimental data, Hatching, Liver flukes,

The chronic effects of the herbicide 2,2-dichlorone enronce electes of the neroticide Z-ductinor-propionic acid (dalapon) on the hatching success of Fossaria cubensis snails after several generations of exposure at sublethal levels were investigated. Snails were reared in dalapon at 0, 0.1, 1.0, or 10.0 Shails were reared in datapon at 0, 0.1, 1.0, or 10.0 mg/L for three successive generations with renewal of the dalapon solutions every 4 d. In the first generation there was 100% hatching of snails in the control by the 14th day while only 5.55%, 8.47% and 66.6% hatched in the 0.1, 1.0 and 10.0 mg/L dalapon groups, respectively. There was also a significant delay in hatching of the young also a significant delay in hatching of the young anails in the dalapon-treated groups. In the 3rd generation, embryo development and hatching had improved in 0.1, 1.0 and 10.0 mg/L dalapon to 29%, 38.2% and 74.7%, respectively, by the 14th day and 100% in all groups by the 20th day. The results indicate that chronic exposure to sublethal concentrations of dalapon may decrease the time required for F. cubensis embryo development and hatching, possibly resulting in more snails available for the propagation of the liver fluke, Fasciola hepatica, which in turn could increase the incidence of liver fluke infections. (MacKeen-PTT) W91-02095 W91-02095

OXYGEN UPTAKE OF PSEUDOSUCCINEA COLUMELLA AND FOSSARIA CUBENSIS TREATED WITH SUBLETHAL CONCENTRA-TIONS OF CUTRINE-PLUS, AN ALGICIDE. Southern Univ., Baton Rouge, LA. Dept. of Bio-

logical Sciences. F. A. Christian, and T. M. Tesfamichael.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 3, p 336-342, September 1990. 1 fig. 2 tab, 13 ref. NIH Grant RR 08025.

# Group 5C-Effects Of Pollution

Descriptors: \*Algicides, \*Oxygen uptake, \*Snails, \*Sublethal effects, \*Toxicology, \*Water pollution effects, Aquatic animals, Chelating agents, Dose-response relationships, Experimental data, Oxygen

The influence of sublethal concentrations of CU-TRINE-PLUS, a copper-chelating algicide, on the oxygen uptake of uninfected (free from trematode larvae) Pseudosuccinea columella and Fossaria cuoxygen uptake of uninfected (free from trematode larvae) Pseudosuccinea columella and Fossaria cubensis was investigated. Snails were treated with CUTRINE-PLUS for 3 h and oxygen consumption measurements taken every 15 min during the test period. The average oxygen consumption of P. columella control snails was 168 O(2) microl/h/g wet weight including the shell, whereas snails treated with 0.3, 0.6, 0.9, and 1.5 ppm CUTRINE-PLUS consumed an average of 127, 106, 101, and 77 O(2) microl/h/g wet weight, respectively. F. cubensis snails treated with 0, 0.3, 0.6, 0.9, and 1.5 ppm CUTRINE-PLUS consumed an average of 178, 126, 123, 122, and 97 O(2) microl/h/g wet weight, respectively. The data indicate that F. cubensis snails were less affected by CUTRINE-PLUS cansumed an average of TRINE-PLUS treatment included inhibition of DNA synthesis, decreased hemolymph oxygen carrying capacity, and inhibition of ATPase activity. (MacKeen-PTT)

METHYLPARATHION-INDUCED ALTERATIONS IN THE ACETYLCHOLINESTERASE AND PHOSPHATASES IN A PENAEID PRAWN, METAPENAEUS MONOCEROS, Sri Venkateswara Univ., Kavali (India). Div. of Texicology. Toxicology.

Toxicology.

M. Srinivosulu Reddy, and K. V. Ramana Rao.
Bulletin of Environmental Contamination and
Toxicology BECTA6, Vol. 45, No. 3, p 350-357,
September 1990. 2 tab, 25 ref.

Descriptors: \*Aquatic animals, \*Enzymes, \*Insecticides, \*Methyl parathion, \*Organophosphorus pesticides, \*Shrimp, \*Toxicology, \*Water pollution effects, Animal metabolism, Dose-response relationships, Enzyme activity, Experimental data, Sublethal effects.

The effects of exposure to methylparathion on the activities of acetylcholinesterase (AChE), acid and alkaline phosphatases (ACPase and ALPase), and on carbohydrate metabolism were studied in the penaeid prawn, Metapenaeus monoceros. Speci-mens were treated with 40 microg/L of methylparathion (one-third of 48 h LC50) for up to 5 days. The AChE activity of thoracic ganglionic mass was significantly inhibited in prawms exposed to methylparathion for 2, 3, 4 or 5 days. The ACPase activity of hepatopancreas was enhanced by expo-sure to the sublethal concentration of methylpar-athion, whereas ALPase activity of this organ was athion, whereas ALPase activity of this organ was inhibited. A significant decrease of hepatic glycogen content was observed after treatment. The hemolymph glucose level was increased up to 4 days of exposure, leading to hyperglycemia. After 5 days of exposure hemolymph glucose was decreased significantly. The inhibition of AChE activity and accumulation of ACh at the synaptic junctions caused by methylparathion exposure may lead to the observed behavioral changes such as hyperexcitability, movement restriction, and loss of hyperexcitability, movement restriction, and loss of coordination and equilibrium, and ultimately, to the death of the organism. (MacKeen-PTT)

TOXICITY EVALUATION OF THE PROPOSED SECONDARY AND THE PRIMARY EFFLUENTS DISCHARGED TO MASSACHU-

Springborn Labs., Inc., Wareham, MA. For primary bibliographic entry see Field 5B. W91-02101

LAKE ACIDIFICATION AND FISHERIES PROJECT: BROOK TROUT (SALVELINUS FONTINALIS) EARLY LIFE STAGES.
Wyoming Univ., Laramic. Fish Physiology and

H. L. Bergman, and J. S. Mattice. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 8, p 1578-1579, August 1990. 17 ref. Electric Power Research In-

Descriptors: "Acid rain effects, "Brook trout, "Fish, "Fish populations, "Lake acidification, "Lake fisheries, "Trout, "Water pollution effects, Acid lakes, Acidic water, Aluminum, Bioassay, Calcium, Embryonic growth stage, Fish eggs, Fish poysiology, Juvenile growth stage, Larval growth stage, Toxicity, Water chemistry.

A brief review of a series of seven papers from the Lake Acidification and Fisheries (LAF) project of the Electric Power Research Institute is presented. The overall goal of the LAF Project is to determine cause-effect relationships between surface mine cause-effect relationships between surface water acidification and fish population responses by integrating bioassay data from the laboratory and water quality and fish population data from the field into a predictive modeling framework. In the set of seven papers, LAF investigators report the results from a series of experiments with brook trout eggs, fry, and juveniles exposed for as long as 91 d to as many as 84 different combinations of pH (4.0-6.5), aluminum (0.1.00 mg/L), and calcium (0.5-8.0 mg/L) representative of acidic and acid-sensitive surface waters. Mortality and growth effects of acid/aluminum exposure were shown to fects of acid/aluminum exposure were shown to depend on life stage. Whole body ion concentra-tions were found to be most affected by water calcium concentration during the full 91-d early life exposure, while pH was the dominant influence life exposure, while pH was the dominant influence on whole body electrolytes during the 21-d yolk sac and swim-up fry exposures. The three final papers explore the effects of pulsed acid/aluminum exposure, aluminum complexation, and the relative sensitivity of different brook trout strains to combinations of acid, aluminum and low calcium concentrations. (See W91-02103 thru W91-02109) (MacK-

EFFECTS OF PH, ALUMINUM, AND CALCI-UM ON SURVIVAL AND GROWTH OF EGGS AND FRY OF BROOK TROUT (SALVELINUS

Wyoming Univ., Laramie. Fish Physiology and Toxicology Lab.
C. G. Ingersoll, D. R. Mount, D. D. Gulley, T. W.

C. G. Ingersoll, D. R. Mount, D. D. Gulley, T. W. La Point, and H. L. Bergman.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 8, p 1580-1592, August 1990. 9 fig. 2 tab, 75 ref. Electric Power Research Institute Contract RP-2346-01.

Descriptors: "Acid rain effects, "Acidic water, "Acidity, "Aluminum, "Brook trout, "Calcium, "Fish, "Fish populations, "Growth, "Hydrogen ion concentration, "Larval growth stage, "Survival, "Trout, "Water pollution effects, Bioassay, Fish eggs, Fish growth, Fish physiology, Fishkill, Life stages, Toxicity, Water chemistry.

Freshly fertilized eggs, eyed eggs, yolk-sac fry, and swim-up fry of brook trout (Salvelinus fontinalis) were exposed to a matrix of 84 combinations of pH (4.0-6.5), aluminum (0.1.00 mg/L), and calcium (0.5-8.0 mg/L) in 21-91-d experiments. The response to pH, aluminum, and calcium was dependent on life stage. Spanishity to each to vicility experiments. sponse to pH, aluminum, and calcium was dependent on life stage. Sensitivity to acid toxicity generally decreased with age (freshly fertilized eggs> eyed eggs > yolk-sac fry=swim-up fry). Survival or hatching of freshly fertilized eggs and eyed eggs decreased at pH 5.2 and below, whereas survival of yolk-sac and swim-up fry was reduced at pH 4.4-4.0. Sensitivity to aluminum toxicity generally increased with age (freshly fertilized eggs=eyed eggs</br>
eyolk-sac fry
At low pH, survival of freshly fertilized and eyed eggs increased with ayour to increasing aluminum concentravival of freshly fertilized and eyed eggs increased with exposure to increasing aluminum concentrations. In contrast, elevated aluminum (greater than or equal to 0.333 mg/L) was often toxic to fry. Increasing calcium was beneficial to all life stages, although the magnitude of this benefit depended on life stage and on the specific pH and aluminum concentration. Survival after previous exposure to toxic combinations of pH, aluminum, and calcium energally improved during a post-exposure recovtoxic combinations of pH, aluminum, and calcium generally improved during a post-exposure recov-ery period at pH 6.5. However, increased mortality

in many exposure combinations did not begin until this recovery period. (See W91-02102 and W91-02104 thru W91-02109) (Author's abstract) W91-02103

EFFECTS OF WATER ACIDITY, CALCIUM, AND ALUMINUM ON WHOLE BODY IONS OF BROOK TROUT (SALVELINUS FONTINA-LIS) CONTINUOUSLY EXPOSED FROM FER-TILIZATION TO SWIM-UP: A STUDY BY IN-STRUMENTAL NEUTRON ACTIVATION ACTIVATION ANALYSIS

McMaster Univ., Hamilton (Ontario). Dept. of Bi-

ology. C. M. Wood, D. G. McDonald, C. G. Ingersoll, D.

C. M. Wood, D. G. McDonald, C. G. Ingersoll, D. R. Mount, and O. E. Johannsson. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 8, p 1593-1603, August 1990. 10 fig. 35 ref. Electric Power Research Institute Contract RP-2346-01.

Descriptors: "Acid rain effects, "Acidic water, "Aluminum, "Analytical methods, "Brook trout, "Calcium, "Electrolytes, "Fish, "Fish populations, "Population exposure, "Trout, "Water pollution effects, Bioassay, Fish eggs, Fish physiology, Hydrogen ion concentration, Life stages, Neutron activation analysis, Tissue analysis, Water chemistry, Whole body ion concentrations.

Water Ca, rather than pH or Al, was the most important factor affecting whole body electrolyte levels in fry exposed from fertilization to swim-up (91 d) to 84 combinations of pH (6.5, 5.2, 4.8, 4.4, 4.0), Ca (0.5, 1, 2, 4, 8 mg/L), and Al (0, 12, 37, 111, 333, 1000 microg/L) in flowing soft water. Aluminum accumulation occurred only at water Al levels >111 microg/L; Al accumulation was inhibited both by increasing Ca and decreasing pH. Under control conditions (pH=6.5, Ca=2 mg/L, Al=0 microg/L), whole body Na, Cl, K, and Ca levels all increased greatly during development, while Mg decreased. Body Ca levels were elevated up to 3-fold, and Na, Cl, and K up to 2-fold by increasing water Ca at the same pH and Al. Low pH had a small negative influence, intermediate levels of Al (37, 111) had a slight positive influence on Na, Cl, K, and Ca levels. Whole body Mg showed opposite trends, reflecting delayed development under adverse conditions. At pH 6.5, the Water Ca, rather than pH or Al, was the most on Na, Cl, K, and Ca levels. Whole body Mg showed opposite trends, reflecting delayed development under adverse conditions. At pH 6.5, the positive influence of increasing water Ca on most whole body ions showed a clear threshold between 0.5 and 1.0 mg/L. At lower pH, this threshold was shifted to between 2 and 8 mg/L, indicating that Ca levels sufficient to support healthy development at circumneutral pH may prove inadequate under acidified conditions. (See W91-02102 thru W91-02103 and W91-02105 thru W91-02109) (Author's abstract) thor's abstract) W91-02104

WHOLE BODY IONS OF BROOK TROUT (SALVELINUS FONTINALIS) ALEVINS: RE-SPONSES OF YOLK-SAC AND SWIM-UP STAGES TO WATER ACIDITY, CALCIUM, AND ALUMINUM, AND RECOVERY EF-FECTS.

McMaster Univ., Hamilton (Ontario). Dept. of Bi-

C. M. Wood, D. G. McDonald, C. G. Ingersoll, D. C. M. Wood, D. G. McDonald, C. G. Ingersoll, D. R. Mount, and O. E. Johannsson. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 8, p 1604-1615, August 1990. 10 fig. 3 tab, 36 ref. Electric Power Research Institute Contract RP-2346-01.

Descriptors: \*Acid rain effects, \*Acidic water, \*Aluminum, \*Brook trout, \*Calcium, \*Electrolytes, \*Fish, \*Fish populations, \*Larval growth stage, \*Trout, \*Water pollution effects, Bioassay, Fish physiology, Hydrogen ion concentration, Life stages, Neutron activation analysis, Water chemistry, Whole body ion concentration

Water pH, rather than Ca or Al, was the most important factor affecting whole body ions in yolk-sac or swim-up fry exposed to a matrix of pH (6.5-4.0), Ca (0.5-8.0 mg/L), and Al (0-1000 microg/L). Fry were raised from fertilization day (day 0) in

# Effects Of Pollution-Group 5C

flowing soft water (pH=6.5, Ca=2 mg/L, Al=0microg/L), exposed to pH/Ca/Al on day 49 (yolk-sac, 2 d post-hatch) or day 70 (swim-up) for 21 d, and then allowed to recover a further 20 d. Yolk-sac fry were extremely resistant at pH greater than or equal to 4.4, developmental effects, as indicated by body weight and Mg, were negligible. However, whole body Na, Cl, K, and Ca were depressed by low pH, while water Ca was protective. Aluminum (37-111 microg/L) raised most ions above control values, while higher Al lowered them. Swim-up fry were more sensitive, showing ions above control values, while higher Al lowered them. Swim-up fry were more sensitive, showing pronounced developmental inhibition (lower weight, higher Mg) under adverse conditions; mortality continued during recovery. Low pH was again the dominant influence on body ions, water Ca was protective, while Al (12-111 microg/L) was only protective and not stimulatory. These was only protective and not stimulatory. In ese effects persisted significantly; indeed responses in body Ca were larger after recovery than after the exposure itself. In the field, emergence from the redd into ambient acidic water is probably the critical stage. Water pH will be the principal determined to the response of the principal determined to the principal minant of whole body ions in alevins surviving this emergence, in contrast to fry exposed continuously from fertilization. (See W91-02102 thru W91-02104 and W91-02106 thru W91-02109) (Author's ab-W91-02105

EPIDERMAL RESPONSE TO PH, ALUMI-NUM, AND CALCIUM EXPOSURE IN BROOK TROUT (SALVELINUS FONTINALIS) FRY.

Wyoming Univ., Laramie. Fish Physiology and Toxicology Lab. C. G. Ingersoll, D. A. Sanchez, J. S. Meyer, D. D.

C. G. Ingersoll, D. A. Sanchez, J. S. Meyer, D. D. Gulley, and J. E. Tietge.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 8, p 1616-1622, August 1990. 1 fig. 2 tab, 58 ref. Electric Power Research Institute Contract RP-2346-01.

Descriptors: \*Acid rain effects, \*Acidic water, \*Aluminum, \*Brook trout, \*Calcium, \*Epidermis, \*Fish, \*Fish populations, \*Hydrogen ion concentration, \*Juvenile growth stage, \*Population exposure, \*Trout, \*Water pollution effects, Analytical methods, Cell morphology, Fish eggs, Fish physiology, Microscopy, Mucous cells, Water chemistry

Eyed brook trout eggs were exposed to various concentrations of pH (4.3-6.3), aluminum (0-1000 microg/L), and calcium (0.5-8.0 mg/L) for 40 d through hatching until the swim-up life stage. High resolution light microscopy, image analysis, and stereological techniques were used to quantitatively determine morphological changes in the epidermis of fry surviving this exposure. Exposure to increased acidity resulted in both mucous cell hypertrophy (increase in size) and hyperplasia (increase in number); exposure to low calcium resulted in mucous cell hyperplasia. Aluminum did not significantly affect mucous cell size or number. Epidermal thickness was not consistently affect microsciently affect mucous cell size or number. significantly affect mucous ceri size or number. Epidermal thickness was not consistently affected by exposure to pH, aluminum, or calcium. The changes observed in epidermal mucous cells may be a compensatory mechanism used by brook trout fry to counter ionoregulatory stress resulting from extended exposure to acidic conditions. (See W91-02102 thru W91-02105 and W91-02107 thru W91-02109) (Author's abstract) W91-02106

RESPONSES OF BROOK TROUT (SALVE-LINUS FONTINALIS) FRY TO FLUCTUATING ACID, ALUMINUM, AND LOW CALCIUM EX-

Wyoming Univ., Laramie. Fish Physiology and Toxicology Lab.
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D. R. Mount, M. J. Swanson, J. E. Breck, A. M. Farag, and H. L. Bergman. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 8, p 1623-1630, August 1990. 2 fig. 2 tab, 41 ref. Electric Power Research Institute Contract RP-2346.

Descriptors: \*Acid rain effects, \*Acidic water, \*Acidity, \*Aluminum, \*Brook trout, \*Calcium, Fish, \*Fish, populations, \*Juvenile growth stage, \*Population exposure, \*Trout, \*Water pollution

effects, Acclimatization, Bioassay, Fish eggs, Fish growth, Fish physiology, Fishkill, Toxicity, Water chemistry, Water quality.

In certain instances, fish kills have been directly associated with acidic 'pulses'. Brook trout fry were exposed for 30 d to temporal combinations of two water qualities: (1) pH 5.21, 51 microg/L total aluminum, with 2.39 mg/L calcium (baseline); and (2) pH 4.59, 329 microg/L total aluminum with 1.56 mg/L calcium (pulse). Although continuous exposure to the pulse conditions caused nearly complete mortality, exposures alternating between the two conditions caused much less mortality. In the two conditions caused much less morality. In fact, fish experiencing 18 d of baseline conditions before their first pulse exposure had mortality rates equal to fish never experiencing a pulse, indicating acclimation to acid/aluminum/low calcium stress. acclimation to acid/aluminum/low calcium stress. The data indicate that the pattern of fluctuating acid/aluminum/low calcium exposure is very important in determining its toxicity, and that the toxicity of acid 'pulses' in field situations may be lower than would be expected from laboratory exposures using naive fish, due to the existence of acclimation. (See W91-02102 thru W91-02106 and W91-02108 thru W91-02109) (Author's abstract) W91-02108 thru W91-02109) (Author's abstract)

INORGANIC MONOMERIC ALUMINUM AND PH AS PREDICTORS OF ACIDIC WATER TOXICITY TO BROOK TROUT (SALVELINUS FONTINALIS)

FONTINALIS). Wyoming Univ., Laramie. Dept. of Zoology and Physiology.
B. R. Parkhurst, H. L. Bergman, J. Fernandez, D. Gulley, and J. R. Hockett.
Canadian Journal of Fisheries and Aquatic Sciences CIFSDX, Vol. 47, No. 8, p 1631-1640, August 1990. 3 fig, 5 tab, 37 ref.

Descriptors: \*Acid rain effects, \*Acidic water, \*Acidity, \*Aluminum, \*Brook trout, \*Fish, \*Fish populations, \*Hydrogen ion concentration, \*Tox-city, \*Trout, \*Water pollution effects, Bioassay, Dissolved organic carbon, Fish physiology, Fish-kill, Fluorides, Regression analysis, Survival, Water chemistry, Water quality, Water tempera-

Inorganic monomeric aluminum concentrations were found to be the primary determinant of survival of brook trout feeding fry exposed for 21 dt ovarious combinations of total aluminum and pH, plus several concentrations of fluoride or dissolved W91-02108

ALUMINUM AND ACID TOXICITY TO TWO STRAINS OF BROOK TROUT (SALVELINUS FONTINALIS).

FUNTINALIS). Wyoming Univ., Laramie. Fish Physiology and Toxicology Lab. C. G. Ingersoll, D. D. Gulley, D. R. Mount, M. E. Mueller, and J. D. Fernandez. Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 8, p 1641-1648, August 1990. 4 fig., 1 tab, 50 ref. Electric Power Research Institute Contract RP-2346-01.

Descriptors: \*Acid rain effects, \*Acidic water, \*Acidity, \*Aluminum, \*Brook trout, \*Fish, \*Fish populations, \*Toxicity, \*Trout, \*Water pollution effects, Bioassay, Calcium, Comparison studies, Fish eggs, Fish growth, Fish physiology, Fishkill, Gills, Histology, Survival, Water chemistry.

Two strains of 1 yr-old brook trout were exposed to 14 combinations of pH, aluminum, and calcium during a 28-d experiment. Survival, weight, and gill histology of both strains were affected similarly by pH, aluminum, and calcium exposure. Survival was reduced at inorganic monomeric aluminum concentrations (IA1) of 29 microg/L at pH 5.2 and greater than or equal to 228 microg/L at pH 9H 4.4 and 4.8. Fish weight was reduced with exposure to pH below 4.8 or aluminum concentrations greater than or equal to 34 microg/L. The concentrations greater than or equal to 34 microg/L. exposure to pri octow 4.0 or automain concentra-tions greater than or equal to 34 microg/L. The gills sampled from fish exposed to low pH exhibit-ed lifting of the outer epithelium and hypertrophy (increase in size) of chloride and epithelial cells. The response of gills sampled from fish exposed to low pH and elevated aluminum was more pronounced relative to the low pH exposure alone. In addition to the effects observed in the low pH exposed fish, the gills from fish exposed to both acid and aluminum exhibited vacuolation and degeneration of epithelial and chloride cells and the presence of dense cells. Finally, fish confined in PVC tubes designed to mimic in situ field exposure procedures were more sensitive to the toxic effects procedures were more sensitive to the toxic effects of acid and aluminum compared to free-swimming fish. Caution must be taken when extrapolating safe field levels from in situ exposures of caged fish. (See W91-02102 thru W91-02108) (Author's W91-02109

ELECTRON MICROSCOPY DOCUMENTING THE CELLULAR METABOLIC FATE OF HG

University of Science, Penang (Malaysia). School of Biological Sciences

of Biological sciences.

P. M. Sivalingam, and R. Billet.
Toxicological and Environmental Chemistry
TXECBP, Vol. 26, No. 1/4, p 1-14, 1990. 9 fig, 3

Descriptors: \*Electron microscopy, \*Mercury, \*Path of pollutants, \*Toxicity, \*Toxicology, \*Water pollution effects, Fish, Fish physiology, Liver, Tilapia, Tissue analysis.

The uptake of toxic heavy metals, including mercury, by aquatic flora and fauna appears to be a phenomenan involving the passive diffusion by direct absorption into the organism. Electron microscope studies of hepatic cellular alterations in fish exposed to a 75 ppl lethal done of inorganic Hg (++) ions (in the form of HgCl2) utilized five precipers of tilapia ranging from 50 to 7.5 cm of the property of the pr nsn exposed to a 75 ppb lethal dose of inorganic the (++) ions (in the form of HgCl2) utilized five specimens of tilapia ranging from 5.0 to 7.5 cm in length. The hepatic cells exposed to mercury for a week were comparatively empty while fat droplets, a few secondary lysosomes and mitochondria were present in the controls. The morphological structure of mitochondria was unaltered, but glycogen levels were depleted. Grape-like globulets resembling fatty bodies formed in the nuclei of the exposed fish; some nuclei possessed a lot of these bodies, while others only formed two or three. These droplets ranged between 0.2-0.5 micrometers in diameter, while those in the cytoplasm averaged 1.2 micrometers. Nevertheless, the nuclear and cellular membranes were normal. In vivo response of hepatic enzymes indicated an increase in alkaline, acid, and glucose-6-phosphatase activities while catalase was inhibited. However, under in vitro conditions all four hepatic enzymes were inhibited at varying rates. These observations show conclusively the depletion of bioenergy in relation minimited at varying rates. Insections rotations show conclusively the depletion of bioenergy in relation to enhanced energy requirements, and indirect in-hibition of oxidative phosphorylative processes in the electron transport system of mitochondria. (Author's abstract) W91-02171

ELECTRON MICROSCOPY DOCUMENTING THE CELLULAR METABOLIC FATE OF ZN

University of Science, Penang (Malaysia). School

Off Biological Sciences
P. M. Sivalingam, and R. Billet.
Toxicological and Environmental Chemistry
TXECBP, Vol. 26, No. 1/4, p 15-26, 1990. 6 fig. 3

#### Group 5C-Effects Of Pollution

Descriptors: \*Electron microscopy, \*Path of pollutants, \*Toxicity, \*Toxicology, \*Water pollution effects, \*Zinc, Enzymes, Fish, Fish physiology,

In vertebrates and invertebrates Zn exists as complexed compounds with metallothioneins. However, its cellular level effects and metabolic fates are er, its cellular level effects and metabolic fates are scantly documented. Electron microscopy is a useful technique for studying hepatic cellular alterations in fish, at a lethal dose exposure of 4.0 ppm over a week. A large number of lysosomes in hepatic cells prevailed on exposure to Za in its sulfate form. Evidently, due to metal compound stress and cellular damage, lysosomal activity is augmented. The lysosomes harbored digestible material, presumably the aforementioned substrates. Fat droplets prevailed, while glycogen depletion was noticeable. Unlike the effects of Hg, the nuclei were normal with granular chromatin and promiwere normal with granular chromatin and promi-nent nucleoli. However, the mitochondria contained some small intramitichondrial bodies. Simitained some small intramitichondrial bodies. Similar to the effects of Hg, the cell membrane remained intact. In vivo enzymatic studies indicated augmentation in catalase, acid and alkaline phosphatases, while glucose-6-phosphatase was inhibited. However, only alkaline and glucose-6-phosphatases were inhibited under in vitro conditions. It is evident that Zn enhances cellular bioenergetic requirements culminating in glycogen depletion owing to stress, concomitantly causing inhibition of oxidative phosphorylation in the electron transport system. (Author's abstract)

ENVIRONMENTAL CHEMISTRY AND BIO-LOGICAL EFFECTS OF CADMIUM COM-

International Association of Environmental Analytical Chemistry, Therwil (Switzerland). For primary bibliographic entry see Field 5B. W91-02173

APPLICATION OF QSARS TO PREDICT PO-TENTIAL AQUATIC TOXICITIES OF ORGAN-OCHLORINE PESTICIDES.

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H. Fiedler, G. Herrmann, K.-W. Shramm, and O.

Hutzinger.
Toxicological and Environmental Chemistry
TXECBP, Vol. 26, No. 1/4, p 157-160, 1990. 1 tab,
7 ref. IRPTC/UNEP Contract No. G/CON/89-

Descriptors: "Aquatic habitats, "Chlorinated hydrocarbons, "Hazard assessment, "Pesticide toxicity, "Pesticides, "Structure-activity relationships, "Water pollution effects, Environmental fate, Model studies, Organic pesticides, Population exposure Prediction

posure, Prediction.

Pesticides, including insecticides, herbicides, fungicides, and rodenticides, are widely used in many industrialized and developing countries. Organochlorine pesticides are still being widely used and are commonly found in surface waters. On the basis of physicochemical data, such as water solubility and vapor pressure, as well as acute toxicity tests, an ecotoxicological model for preliminary hazard assessment has been developed using data mostly collected from the literature. The Quantitative Structure Activity Relationship (QSAR) system was used to make predictions about the potential threat of chlorinated pesticides to aquatic organisms. By use of the reciprocal product for log H and LCS0 a suitable ranking system was developed that allows the prediction of potential damage to aquatic organisms through pesticides. The QSAR system estimated chemical properties, environmental fate, and toxicity of organic compounds using models based upon chemical structure. The preliminary hazard assessment consists of an evaluation of potential exposure and the potential effects of that exposure. (Tappert-PTT)

SURVIVAL OF STRIPED BASS LARVAE AND YEARLINGS IN RELATION TO CONTAMINANTS AND WATER QUALITY IN THE UPPER CHESAPEAKE BAY.

Johns Hopkins Univ., Shady Side, MD. Aquatic Ecology Section.
L. W. Hall, A. E. Pinkney, R. L. Herman, and S.

L. W. Hall, A. E. Finkney, R. E. Hallman, and E. Finger.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 4, p 391-400, July 1987. 1 fig. 8 tab, 21 ref. The Johns Hopkins University/FWS Cooperative Agreement No. 14-16-0009-85-910.

Descriptors: \*Bass, \*Chesapeake Bay, \*Estuarine environment, \*Larval growth stage, \*Survival, \*Water pollution effects, Acute toxicity, Animal pathology, Fish pathology, Fishkill, Histology, Laboratory methods, Larvae, Toxicology.

Laboratory methods, Larvae, Toxicology.

This study was designed to: evaluate the survival of striped bass yolk-sac larvae and yearlings at three locations in their natural spawning habitat in the upper Chesapeake Bay (Chesapeake and Delaware Canal) using 'in situ' chambers; correlate larval and yearling survival with the presence of 11 water quality parameters, 10 inorganic contaminants and 21 organic contaminants; and assess histological effects on yearlings after exposure to habitat water. The cumulative percent survival anged from 42-59-5% for striped bass larvae after 96 hr of exposure to habitat water during two experiments. Survival in control conditions during these two experiments was 77.5% and 80.5%. Data from previous studies have shown that mortality rates for wild yolk-sac larvae ranged from 7-19% per day. Daily mortality of larvae in the present study was 13-16%; therefore, suspected acutely harmful water quality or contaminant conditions affecting survival were not substantiated. All yearling striped bass survived 10 days of exposure to affecting survival were not substantiated. All year-ling striped bass survived 10 days of exposure to habitat water. Although habitat water was not acutely toxic, histological examination of surviving yearling striped bass indicated sublethal effects. Telangiectases (lamellar dilations) of the gills was reported for yearlings exposed to habitat water. This pathological change was not found in the controls. (Author's abstract)

SHORT-TERM EXPOSURE OF ZOOPLANK-TON TO THE SYNTHETIC PYRETHROID, FENVALERATE, AND ITS EFFECTS ON RATES OF FILTRATION AND ASSIMILA-TION OF THE ALGA, CHLAMYDOMONAS REINHARDII.

Guelph Univ. (Ontario). Dept. of Environmental

Biology.

K. Day, and N. K. Kaushik.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 4, p 423-432, July 1987. 3 fig. 3 ref, 41 ref.

Descriptors: \*Acute toxicity, \*Bioindicators, \*Chlamydomonas, \*Fenvalerate, \*Pesticides, \*Toxicology, \*Water pollution effects, \*Zooplank-ton, Bioassay, Biological studies, Daphnia, Feeding rates, Laboratory methods, Lethal limit, Water-

The feeding behavior of zooplankton is a physiological function which may be of value in the study of the toxicity of pollutants to aquatic organisms. In acute tests of toxicity, two cladocerans, Daphnia galeata mendotae and Ceriocaphnia lacustris, and the calanoid, Diaptomus oregonesis, were more sensitive to fenvalerate (FV) than Daphnia magna, the organism used in standard laboratory bioassays. The 48-hr 50% lethality concentrations bioassays. The 48-hr 50% lethality concentrations (EC50s) for each species/stage in order of increasing sensitivity were adult D. magna-2.52 micrograms/L; D. magna (</=48-hr old)-0.83 micrograms/L; adult D. galeata mendotae-0.29 micrograms/L; adult C. lacustris-0.21 micrograms/L; D. galeata mendotae (</=48-hr old)-0.16 micrograms/L; and adult Diaptomus oregonensis-0.12 micrograms/L. No toxicity was observed when these organisms were exposed to a range of concentrations of the emulsifiable concentrate without FV (the EC blank). Rates of filtration of the 14-C blank) Rates of filtration of the 14-C blank) Rates of filtration of the 14-C blank) Rates of filtration of the 14-C blank). FV (the EC blank), Rates of illtration of the 14-C labeled alga, Chlamydomonas reinhardii by D. galeata mendotae, C. lacustris and D. Oregonensis were decreased significantly at sublethal concentrations of FV after only 24-hr exposure. Ceriodaphnia lacustris showed the greatest sensitivity with rates of filtration significantly decreased at 0.01 micrograms FV/L. Concentrations of FV >/ 0.01 micrograms FV/L. Concentrations of FV >/
=0.05 micrograms/L resulted in decreased rates of filtration by D. galeata mendotae. A concentration of 0.10 micrograms FV/L caused rates of filtration to increase in D. oregonensis, whereas 0.05 and 0.5 micrograms/L resulted in a decrease in these rates. Rates of assimilation of algae by D. galeata mendotae, C. lacustris and D. oregonensis exposed to similar concentrations of fenvalerate were decreased at concentrations >= 0.05 micrograms FV/L. Changes in rates of assimilation were not as sensitive a parameter of toxicity as changes in rates sensitive a parameter of toxicity as changes in rates of filtration. The EC blank had no significant ef-fects on rates of filtration or assimilation for all three species. (Author's abstract) W91-02195

CHANGES IN PLASMA, LIVER, AND OVARY VITELLOGENIN IN LANDLOCKED ATLANTIC SALMON FOLLOWING EXPOSURE TO SUBLETHAL CYANIDE.

Concordia Univ., Loyola Campus, Montreal (Quebec). Dept. of Biology. S. M. Ruby, D. R. Idler, and Y. P. So.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 4, p 507-510, July 1987. 1 fig, 1 tab, 30 ref.

Descriptors: \*Acute toxicity, \*Cyanide, \*Fish physiology, \*Salmon, \*Toxicology, \*Water pollution effects, Immunoassay, Laboratory methods,

Hydrogen cyanide (HCN) is a toxicant that occurs frequently in terrestrial and aquatic ecosystems both naturally and from man-made sources, and trequently in terrestrail and aquatic ecosystems both naturally and from man-made sources, and affects fish physiology, particularly reproduction. Female landlocked Atlantic salmon (Salmo salar Ouananiche) were exposed to 0.005 mg/L HCN for 12 days at 7 +/-1 C during late vitellogenesis cottober). Plasma vitellogenia and liver and gonad vitellogenin-like protein (VLP) levels were measured by homologous radioimmunoassay specifically developed for this species. Results indicated that plasma vitellogenin levels increased in cyanide-exposed fish. VLP levels in the liver did not change relative to control fish suggesting that the increased levels of plasma vitellogenin did not result from a change in synthesis in the liver. VLP levels declined in the gonad relative to the controls by day 12. Elevated plasma vitellogenin levels along with decreased VLP in the gonads suggest that exposure of female salmon to sublethal HCN during late vitellogenesis inhibits the uptake of vitellogenin at the ovarial level. The recommended safe concentration for cyanide (0.005 mg/L) which safe concentration for cyanide (0.005 mg/L) which offers a safe water quality objective alters patterns of plasma vitellogenin just prior to spawning. (Author's abstract) W91-02196

SHORT-TERM LETHALITY AND SEDIMENT AVOIDANCE ASSAYS WITH ENDRIN-CON-TAMINATED SEDIMENT AND TWO OLIGO-CHAETES FROM LAKE MICHIGAN.

Michigan Univ., Ann Arbor. Great Lakes Re-

T. J. Keilty, D. S. White, and P. F. Landrum. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 1, p 95-101, January 1988. 2 fig. 4 tab, 35 ref. Great Lake Environmental Research Laboratory/NOAA Cooperative Agreement NA81-RA-H-00003.

Descriptors: \*Acute toxicity, \*Bioassay, \*Endrin, \*Lake Michigan, \*Lake sediments, \*Oligochaetes, \*Path of pollutants, \*Sediment contamination, \*Toxicology, \*Water pollution effects, Animal behavior, Benthic fauna, Fate of pollutants, Halogenated periodices.

Toxic compounds with high partition coefficients that enter the Laurentian Great Lakes adsorb significantly to fine particles and settle to the bottom. niticantly to line particles and settle to the bottom. The fate of these compounds and their interactions with the larger benthic organisms is largely unknown. Mean 96-hr 50% lethality (LC50) values and standard deviations for the oligochaetes Stylodrilus heringianus and Limnodrilus hoffmeisteri exposed to endrin-contaminated sediments were

# Effects Of Pollution-Group 5C

2588+/-1974 micrograms/g dry weight sediment for 4 assays and 2725+/-955 micrograms/g for 2 assays, respectively. Mixed species testing data suggested that the toxicity to L. hoffmeisteri was reduced in the presence of S. heringianus, yet further testing is required. Ninety-six hour 50%-effective (EC50) burrowing avoidance values for both species (19 and 15.3 microgram/g for S. heringianus and 59 micrograms/g for L. hoffmeisteri) were approximately 46 and 150 times lower than their respective mean 96-hr LC50 values. Both S. heringianus and L. hoffmeisteri initially burrowed in contaminated sediment and then returned to the surface in numbers somewhat proportional to the surface in numbers somewhat proportional to the sediment concentration and length of exposure. Future use of oligochaete behavioral responses to sublethal sediment contamination for pollution impact on benthic communities is promising. (Aur's abstract)

ARTIFICIALLY INDUCED METAMORPHOSIS

ACETONE IN ACRIS GRYLLUS.
Tennessee State Univ., Nashville. Dept. of Biologi-

S. Pollard, and J. A. Adams

S. Foliard, and J. A. Adams. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 4, p 419-428, July 1988. 8 fig, 2 tab, 21 ref. NIH Grant No. SO6RR08092.

Descriptors: \*Acetone, \*Amphibians, \*Bioindicators, \*Frogs, \*Metamorphosis, \*Toxicology, \*Water pollution effects, Hormones, Iodine, Laboratory methods, Larval growth stage, Thyroid gland.

The causative agents (hormones) involved in amphibian metamorphosis as well as the involved specific endocrine organs have been well established for decades. Tri-iodothyronine and thyroxin, both secretions of the larval thyroid gland, are directly responsible for metamorphosis under physiological conditions. High amounts of the element iodine (approximately 300 times the amount found in equally effective levels of thyroxin) can also induce metamorphosis in amphibians. In a search for an appropriate emulsifier to be employed in studying the effects of hydrophobic polychlorinated biphenyls (PCBs) on metamorphosis, reagent-grade acetone (a commonly-used carrier molecule for PCBs) was found to be a potent inducer of metamorphosis in Acris gryllus (a cricket frog species). The acetone was employed as a component of an artificial pond water medium. Other test conditions included exposure to thyroxin and dimethyl sulfoxide for comparison. Not only was metamorphosis enhanced in the acetone-treated animals, but the effect was concentration-dependent when acetone levels of 10 mg/L and 50 mg/L were employed. The 50 mg/L acetone-treated group showed precocious metamorphosis at a rate not significantly different from that produced by thyroxin. Dimethyl sulfoxide exposure produced no significant increase in metamorphic rate. (Author's abstract) The causative agents (hormones) involved in an duced no significant increase in metamorphic rate.
(Author's abstract)
W91-02201

EFFECTS OF ATRAZINE ON FRESHWATER MICROBIAL COMMUNITIES.

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of Forest Resources.
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J. Carris.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 4, p 449-457, July 1988. 2 fig. 4 tab, 44 ref. EPA Grant R-812813-01-0 and Air Force Office of Scientific Research Grant AFOSR-85-0324.

Descriptors: \*Atrazine, \*Bioassay, \*Bioindicators, \*Herbicides, \*Pesticides, \*Toxicity, \*Toxicology, \*Water pollution effects, Algae, Aquatic fungi, Biomass, Calcium, Chlorophyll a, Colonization, Dissolved oxygen, Laboratory methods, Magnesium, Microbial degradation, Proteins, Protozoa, Species diversity.

A multispecies toxicity test system using naturally-derived microbial communities (comprised of bac-teria, fungi, protozoa, algae and micrometozoans)

on polyurethane foam substrates was used to evaluate the toxic effects of the herbicide atrazine. Both ate the toxic effects of the herbicide atrazine. Both structural (e.g., protozoan species number, biomass) and functional (e.g., colonization rate, oxygen production) community responses were measured. Oxygen production and the ability of communities to sequester Mg and Ca were the most sensitive measures of toxic stress due to atrazine (maximum allowable toxicant concentrations (MATCs) = 17.9 micrograms/L). Dissolved oxygen was 33% lower, and there was 15% less Ca and Mg in communities at and above 32.0 micrograms/L atrazine compared to controls. Species richness and estimates of biomass (total protein and chlorophyll a) were less sensitive (MATCs = 193) to atrazine. At the highest atrazine concentration (337 micrograms/L), species numbers were numbers were supported to the structure of the st tion (337 micrograms/L), species numbers were 30% lower than controls, and protein and chloro-30% lower than controls, and protein and chlorophyll a content of communities were reduced by 38 and 91%, respectively. Low levels of atrazine (3.2-32.0 micrograms/L) resulted in a 46% increase in species numbers and a greater concentration of total protein and chlorophyll a (41 and 57%, respectively). Results compared well with other estimates of chronic toxicity for effects of atrazine on aquatic communities. Reported MATCs ranged from 70.7 to 3400 micrograms/L. The results from this test emphasize the importance of monitoring both structural and functional measures of communities. both structural and functional measures of comm nity integrity in toxicity testing with multispecies (Author's abstract) W91-02202

RESPONSES OF ZOOPLANKTON AND CHAOBORUS TO TEMEPHOS IN A NATURAL POND AND IN THE LABORATORY.
Saint Olaf Coll., Northfield, MN. Dept. of Biol-

ogy.

J. C. Helgen, N. J. Larson, and R. L. Anderson.

Archives of Environmental Contamination and
Toxicology AECTCV, Vol. 17, No. 4, p 459-471,
July 1988. 9 fig. 4 tab, 24 ref. EPA/St. Olaf College Cooperative Agreement Cr-810016-01.

Descriptors: \*Bioindicators, \*Chronic toxicity, \*Organophosphorus pesticides, \*Pesticides, \*Ponds, \*Toxicology, \*Water pollution effects, \*Waterfleas, \*Zooplankton, Acute toxicity, Bioas-say, Copepods, Daphnia, In situ tests, Laboratory methods, Larval growth stage, Life cycles, Minne-sota, Risk assessment, Rotifers.

A two year field study was performed on the effects of the organophosphorus insecticide temephos on zooplankton and the phantom midge larva Chaoborus americanus in natural ponds in central Minnesota. Application of temephos to a pond was followed by reduction within 24 hr in all cladocerrollinesota. Application of teneprots to a point was followed by reduction within 24 hr in all cladocerans, in Diaptomus leptopus and in C. americanus, and increases in cyclopoid copepods, copepod nauplii and the rotifer Keratella cochlearis. Daphnia pulex that reappeared 35 days post-application were ex-ephippial. After application, reproduction of cladocerans and Diaptomus was markedly reduced compared to the previous year, an effect attributed to temephos. Daphnia population density was strongly reduced into the fall season, long after the spring applications, compared with both a reference pond's and the previous season's populations. On-site bioassays demonstrated 24-hr mortalities of Daphnia and Chaoborus that were comparable to the population decreases in the pond. Laboratory toxicity tests showed Daphnia was the most sensitive followed by Chaoborus and Diaptomus. Comparable results were seen in the pond mus. Comparable results were seen in the pond population changes, in situ bioassays and laboratory toxicity data for Daphnia and for Chaoboratory, but sensitivities in the pond were somewhat greater than in the laboratory. Risk assessment research calls for long-term field reproduction analysis to avoid a false 'recovery' report, combined with laboratory life cycle analysis and short acute exposure tests. (Author's abstract) W91-02203 mus. Comparable results were seen in the pond

CALCIUM METABOLISM IN TWO POPULA-TIONS OF THE SNAIL HELIX ASPERSA ON A

HIGH LEAD DIET.
Polytechnic of the South Bank, London (England). Dept. of Biotechnology.

A. Beeby, and L. Richmond.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 4, p 507-511, July 1988. 3 fig, 3 tab, 20 ref.

Descriptors: \*Air pollution effects, \*Animal metabolism, \*Calcium, \*Lead, \*Snails, \*Toxicology, Bioassay, Chemical analysis, Excretion, Heavy metals, Magnesium, Trace metals.

The uptake and loss of toxic metals by organisms may depend on their mechanisms for binding and excreting essential metals. Ca is often associated with heavy metal retention in vertebrates and invertebrates. Soft tissue concentrations of Pb, Ca vertebrates. Soft tissue concentrations of Pb, Ca and Mg were measured in two populations of the garden snail, Helix aspersa, over a 64-day dosing regime to determine if differences in Pb metabolism could be predicted by differences in Ca metabolism. Snails compared from an uncontaminated site and from a grossly polluted car park. In each case, 25 snails were given a diet with 500 micrograms/g Pb (as PbSO4), and 25 were removed to a Pb-free diet after two days on the Pb dose. The snails from the car park maintained a higher concentration of Ca in the soft tissues, and assimilated Ca faster on a high Pb diet. Concentrations of Pb and Ca can be correlated for the soft tissues of the dosed car park snails. No such relationship was dosed car park snails. No such relationship was found for the snails from the rural site. The rate of To a assimilation may determine the excretion rate of intracellular granules, where Pb is bound. Population differences in Pb uptake might result from variations in Ca metabolism, which, in the car park snails, could represent an adaptation to high ambient Pb. (Author's abstract) W91-02205

SELENIUM TERATOGENESIS IN NATURAL POPULATIONS OF AQUATIC BIRDS IN CENTRAL CALIFORNIA.

Patuxent Wildlife Research Center, Laurel, MD. D. J. Hoffman, H. M. Ohlendorf, and T. W.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 4, p 519-525, July 1988. 8 fig, 2 tab, 28 ref.

Descriptors: \*California, \*Kesterson Reservoir, \*Selenium, \*Teratogenic effects, \*Water birds, \*Water pollution effects, \*Waterfowl, Agricultural runoff, Eggs, Embryonic growth stage, Liver, Trace metals.

The frequency and types of malformations are described that were encountered during the spring described that were encountered during the spring of 1983 in a natural population of aquatic birds exposed to agricultural drainwater ponds and food items containing high concentrations of Se in central California. A total of 347 nests of aquatic birds containing 1,681 eggs was selected for study at Kesterson Reservoir located in the Kesterson National Wildlife Refuge, Merced County, California. Embryos collected during incubation or from eggs that failed to hatch were examined to determine the new act death and preserve of multirantine. that railed to hatch were examined to the ear at death and presence of malformations. Embryonic death was generally high; approximately 17-60% of the nests of different species contained at least one dead embryo. The incidence of tained at least one dead emoryo. In emicience of malformed embryos was also high; approximately 22-65% of the nests where at least two embryos were examined contained abnormal embryos. American coots (Fulica americana) and blacknecked stilts (Himantopus mexicanus) experienced the highest incidence of malformed embryos. For the highest incidence of malformed embryos. For all species, the average percentage of eggs containing dead or live abnormal embryos was 16.1 whereas the average percentage containing live abnormal embryos was 10.7. Multiple gross malformations of the eyes, brain, and feet were often present. Brain defects included hydrocephaly and exencephaly. Eye defects included both unilateral and bilateral anophthalmia and microphthalmia. Eye and foot defects with ectrodactyly and swoler ichits were the most common in coots. Beak Eye and foot defects with ectrodactyly and swolen joints were the most common in coots. Beak defects also occurred frequently and most often included incomplete development of the lower beak of ducks (Anas spp.) and stills. Wing and leg defects were most prevalent in stilts and ducks, with ectromelia and amelia most prevalent in stilts. Other malformations occurring at lower frequencies included enlarged hearts with thin ventricular

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walls, liver hypoplasia, and gastroschisis. Based upon simultaneous examination of a control population of aquatic birds of the same species and published studies, the incidences of embryonic mortality and deformities were 9-30 times greater than expected. (Author's abstract) W91-02206

WEATHERED CRUDE OIL EFFECTS ON CHICKS OF FORK-TAILED STORM-PETRELS (OCEANODROMA FURCATA).
Washington Univ., Seattle. Inst. for Environmental

Studies.
P. D. Boersma, E. M. Davies, and W. V. Reid.
Archives of Environmental Contamination and
Toxicology AECTCV, Vol. 17, No. 4, p 527-531,
July 1988. 3 tab, 23 ref.

Descriptors: \*Chronic toxicity, \*Hydrocarbons, \*Oil pollution, \*Prudhoe Bay, \*Toxicology, \*Water birds, \*Water pollution effects, Marine pollution, Oil, Oil spills

Adult Storm-Petrels had between 0.004 and 0.0008 ml of fossil fuel hydrocarbons present in their food samples when they were considered contaminated. Chicks of Fork-Tailed Storm-Petrels (Oceanotroma furcata) were fed 0.1 ml of weathered Prudhoe Bay crude oil, which should be close to the maximum dose that they might receive at a feeding. Chicks dosed orally once, twice, or weekly with 0.1 ml weathered Prudhoe Bay crude oil did not differ significantly in gross morphology, bill, tarsus, or wing growth from control chicks. Chicks dosed one time gained weight between the ages of 0-21 days at significantly slower rates. Chicks aged 22-51 days grew similarly regardless of treatment. Dosed chicks fledged on average two days later than control chicks. Ingesting small amounts of weathered oil had little effect perhaps because Storm-Petrels may be able to ingest long-chained hydrocarbons (like petroleum) with relative impunity, because these compounds are relatively non-Adult Storm-Petrels had between 0.004 and 0.0008 nity, because these compounds are relatively non-toxic and are part of their normal diet. (Author's

ECOLOGY OF A SOUTHERN OHIO STREAM RECEIVING FLY ASH POND DISCHARGE: CHANGES FROM ACID MINE DRAINAGE

American Electric Power Service Corp., Columbus, OH. Environmental Engineering Div. R. J. Reash, J. H. Van Hassel, and K. V. Wood. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 4, p 543-554, July 1988. 3 fig, 4 tab, 46 ref.

Descriptors: "Acid mine drainage, "Acid streams, "Ecological effects, "Ecosystems, "Fly ash, "Ohio, "Stabilization ponds, "Waste disposal, "Water pol-lution effects, "Water pollution treatment, Benthic environment, Benthic fauna, Electric power indus-try, Electric powerplants, Fish, Hydrogen ion con-centration, Species diversity, Water pollution con-trol.

Prior to 1975, Stingy Run was a third-order tribu-tary of Kyger Creek, which empties into the Ohio River at Mile 260 (Gallia County, Ohio). Both streams drained strip mine refuse areas and physicochemical measurements indicated acidic-mine drainage conditions (e.g., low pH). A depauperate macroinvertebrate community, dominated by a few acid-tolerant taxa, was found in both streams and no fishes were collected. In 1974, Stringy Run and no fishes were collected. In 1974, Stingy Run was impounded to form a fly ash pond which contains fly ash sluiced from Ohio Power Company's General James M. Gavin coal-fired power plant. Physicochemical and biological sampling during 1975-1986 indicated marked changes in the aquatic ecology of Stingy Run between (1) pre-impoundment and post-impoundment conditions; and (2) effluent pH control treatments after impoundment. Fly ash discharge eliminated acidicmine drainage characteristics in Stingy Run and lower Kyger Creek. After impoundment, ret spinning caddisflies and a few dipteran taxa dominated the Stingy Run benthic community, reflecting changes in functional niches likely due to improved habitat and greater food availability. Re-

placement of acid feed by CO2 injection for effluent pH control and changes in ash pond chemistry occurred concomitant with elimination of a sub-strate floc; increased species richness and densities of invertebrates were subsequently observed. In Stingy Run, species richness and diversity of fishes Stingy Kun, species richness and diversity of fishes increased from 1983 to 1986, reflecting improved water quality and increased benthic production after impoundment. Many of these fishes are opportunistic feeders on drifting insects. (Author's abstract) W91-02208

METHODS FOR ASSESSING FERTILIZATION AND EMBRYONIC/LARVAL DEVELOPMENT IN TOXICITY TESTS USING THE CALIFOR-NIA MUSSEL (MYTILUS CALIFORNIANUS). California Univ., Bodega Bay. Bodega Marine Lah

For primary bibliographic entry see Field 5A. W91-02212

POPULATION-SPECIFIC TOXICITY RE-SPONSES BY THE FRESHWATER OLIGO-CHAETE, STYLODRILUS HERINGIANUS, IN NATURAL LAKE MICHIGAN SEDIMENTS. National Oceanic and Atmospheric Administra-tion, Ann Arbor, MI. Great Lakes Environmental Research Lab.

T. J. Keily, and P. F. Landrum.
Environmental Toxicology and Chemistry
ETOCDK, Vol. 9, No. 9, p 1147-1154, September
1990. 9 fig, 1 tab, 19 ref.

Descriptors: \*Aquatic populations, \*Bioassay, \*Bioindicators, \*Lake Michigan, \*Lake sediments, \*Oligochaetes, \*Sediment contamination, \*Toxicity, \*Toxicology, \*Water pollution effects, Aniab behavior, Chronic toxicity, Laboratory methods,

Sediment reworking rate, mortality and organism dry weight were measured for Stylodrilus herin-gianus in laboratory microcosms. The experiments were designed to identify potential population-spewere designed to identify potential population-spe-cific response differences to mixed (stirred to obtain a more uniform particle size distribution over depth) and unmixed (passively settled) micro-cosm sediments. Lake Michigan sediments and worms were collected off Benton Harbor, Michigan and Grand Haven, Michigan. The mixed Benton Harbor sediments were toxic to S. herin-gianus collected from Grand Haven, whereas there were no significant differences in measured responses between mixed and unmixed sediment mi-crocosms for Grand Haven-collected worms exposed to Grand Haven sediments or Benton Harbor-collected worms exposed to Benton Harbor sediments. Note that the mixing of sedi-ments resulted in increased availability of contaminants sorbed to the fine sediment fraction. Because contaminant and oligochaete population data suggest that Grand Haven sediments are less contami-nated, the population-specific response suggests that S. heringianus may adapt to the low level long-term stressful conditions (chemical or otherwise). Results also suggest caution and consider-ation of the history of test organisms in the design and interpretation of toxicity tests. (Author's abstract) W91-02213

AVOIDANCE OF SELENIUM-TREATED FOOD BY MALLARDS.

stuxent Wildlife Research Center, Laurel, MD.

G. H. Heinz, and C. J. Sanderson.
Environmental Toxicology and Chemistry
ETOCDK, Vol. 9, No. 9, p 1155-1158, September
1990. 1 tab, 8 ref. USFWS/San Joaquin Valley
Drainage Program Interagency Agreement 6-AA20-04170.

Descriptors: \*Animal behavior, \*Ducks, \*Food habits, \*Selenium, \*Toxicology, \*Water pollution effects, Feeding rates, Toxicity, Water birds, Water b

The first step in understanding whether avoidance of selenium-treated diets in laboratory studies will limit extrapolation of results to the field is to

determine why birds avoid these diets in the laboratory. Adult, male mallards (Anas platyrhynchos) were given a choice between a control diet and a diet containing 5, 10 or 20 ppm selenium as selenomethionine dissolved in water and mixed into the diet. At 10 and 20 ppm, selenium-treated diets were avoided. Avoidance appeared to be caused by a conditioned response, probably to illness caused by the selenium and not to an aversion to the taste of the selenium. A comparison of the acceptance by wild birds of selenium in natural foods and laboratory diets is needed. (Author's abstract) W91-02214 W91-02214

STAGE SPECIFIC TOXICITY OF 2,3,7,8-TE-TRACHLORODIBENZO-P-DIOXIN IN EM-BRYOS OF THE JAPANESE MEDAKA (ORY-ZIAS LATIPES).

Rutgers - The State Univ./UMDNJ-Robert Wood Johnson Medical School, Piscataway, NJ. Joint Graduate Program in Toxicology.

J. D. Wisk, and K. R. Cooper.

Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 9, p 1159-1169, September 1990. 6 tab, 31 ref. NJ Department of Environmental Protection/USGS D-10407-2-88.

Descriptors: \*Dioxins, \*Embryonic growth stage, \*Fish, \*Medaka, \*Toxicity, \*Toxicology, \*Water pollution effects, Acute toxicity, Animal pathology, Fertilization, Liver, Median tolerance limit, Sublethal effects.

Embryos of the Japanese medaka were individually exposed to varying concentrations of (H3)2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) (H3)/<sub>6</sub>,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in a static, nonrenewal system. The EC50 with 95% confidence interval (C.I.) to prevent hatching was 14(11-17) nanograms (ng) TCDD equivalents/ L of water (parts per trillion). The LC50 with 95% C.I. for survival to 3 d posthatch was 9(6-12) ng TCDD equivalent/L. The EC50 with 95% C.I. for rembryos with minor lesions and severe, life-threat-ening lesions were 3.5(1.3-5.7) ng TCDD equiva-lents/L and 14(12.4-15.6) ng TCDD equivalents/ L, respectively. In a separate experiment that was terminated prior to the embryos hatching or dying, the EC50 for lesions was calculated to be 2.2(1.4the EC50 for lesions was calculated to be 2.2(1.4-3.0) ng TCDD equivalents/L. Based on the amount of TCDD equivalents recovered from dechorionated embryos, the ED50 with 95% C.I. for lesions was calculated to be 0.24 picograms TCDD equivalents/mg of dechorionated embryo weight (parts per billion). When the embryos were exposed to (H3)TCDD with 1 to 2 h after fertilization, no concentration dependent increase in visible lesions was observed until after the formation of the liber regiment (day 4 of development). But lesions was observed until after the formation of the liver rudiment (day 4 of development). By exposing Japanese medaka embryos to lethal concentrations of TCDD beginning on different days of embryonic development, it was demonstrated that the sensitive period for toxicity was during liver formation on day 4 or 5 of development. The sensitive period for development was not caused by differences in TCDD absorption across the chorion. When embryos were exposed to (H3)TCDD prior to, during or after liver formation, there was no statistical difference in the dose of TCDD equivalents that crossed the chorion and entered the yolk and embryo. (Author's abstract) entered the yolk and embryo. (Author's abstract) W91-02215

TOXICITY OF INORGANIC AND ORGANIC SELENIUM TO DAPHNIA MAGNA (CLADOCERA) AND CHIRONOMUS RIPARUS (DIP-

National Fisheries Contaminant Research Center, Columbia, MO.

C. G. Ingersoll, F. J. Dwyer, and T. W. May. Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 9, p 1171-1181, September 1990, 6 tab. 57 ref.

Descriptors: \*Acute toxicity, \*Bioaccumulation, \*Chronic toxicity, \*Daphnia, \*Kesterson Reservoir, \*Midges, \*Selenium, \*Toxicology, \*Water pollution effects, California, Chlorides, Food chains, Larval growth stage, Magnesium, Potassium, Sodium, Toxicity, Trace metals.

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Elevated concentrations of Se have been previously measured in biota sampled from the Kesterson National Wildlife Refuge (KNWR) in the San Joaquin Valley of central California. Acute and chronquin Valley of central California. Acute and chronic toxicity tests were conducted with the cladoceran Daphnia magna and the midge Chironomus riparius to determine the toxicity or bioaccumulation of waterborne Se in a reconstituted water similar to the San Joaquin River. Daphnids were more acutely sensitive than midges to the effects of inorganic Se. An organic form of Se (seleno-(L)-methionine) was extremely toxic to daphnids, but were relativally profitive to midge. In long term was relatively nontoxic to midges. In long-term exposure to a 6:1 mixture of selenate to selenite (a mixture representative of KNWR), the emergence time of adult midges was delayed at Se concentratime of adult midges was delayed at Se concentrations >= 837 micrograms/L. Daphnid reproduction and intrinsic rate of natural increase (r) were reduced at Se concentrations >= 348 micrograms/L and growth of adults were reduced at >= 156 micrograms/L. Whole body Mg, K and Na concentrations in daphnids were not affected by chronic Se exposure; however, whole body Ca concentration increased at intermediate Se exposure concentrations. In addition, whole body Cl concentration was reduced at 711 micrograms Se/L. Daphnids accumulated potentially toxic concentrations of Se from water that may adversely affect fish or waterfowl through the food chain. (Author's abstract) thor's abstract) W91-02216

RAINBOW TROUT LIVER ACTIVATION SYSTEMS WITH THE AMES MUTAGENICITY

National Fisheries Contaminant Research Center, Columbia, MO.

For primary bibliographic entry see Field 5A. W91-02217

COMPARATIVE EVALUATION OF FIVE TOX-ICITY TESTS WITH SEDIMENTS FROM SAN FRANCISCO BAY AND TOMALES BAY, CALI-

National Ocean Service, Seattle, WA. Ocean As-

For primary bibliographic entry see Field 5A. W91-02218

SUMMARY OF BIOLOGICAL INVESTIGA-TIONS RELATING TO SURFACE-WATER QUALITY IN THE KENTUCKY RIVER BASIN,

Geological Survey, Reston, VA. Water Resources

A. D. Bradfield, and S. D. Porter. A. D. Braunett, and S. D. Forter. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Water-Resources Investigations Report 90-4051, July 1990. 63p, 7 fig, 1 tab, 205 ref.

Descriptors: \*Algae, \*Aquatic insects, \*Bioindica-tors, \*Biological communities, \*Ecology, \*Ken-tucky River, \*Mine drainage, \*Water pollution effects, Benthic fauna, Benthic flora, Brines, Mus-sels, Pollutant identification, Stream fisheries.

The Kentucky River basin, an area of approximately 7,000 sq mi, is divided into five hydrologic units that drain parts of three physiographic regions. Data on aquatic biological resources were collected and reviewed to assess conditions in the major streams for which data were available. The North, Middle, and South Forks of the Kentucky River are in the Eastern Coal Field physiographic River are in the Eastern Coal Field physiographic region. Streams in this region are affected by drainage from coal mines and oil and gas operations, and many support only tolerant biotic stream forms. The Kentucky River from the confluence of the three forks to the Red River, is in the Knobs physiographic region. Oil and gas production operations and point discharges from municipalities have affected many streams in this region. The Red River, a Kentucky Wild River, supported a unique flora and fauna but accelerated sedimentation has eliminated many species of mussels. The unique flora and rauna but accelerated seculmenta-tion has eliminated many species of mussels. The Millers Creek drainage is affected by brines dis-charged from oil and gas operations, and some reaches support only halophilic algae and a few fish. The Kentucky River from the Red River to

the Ohio River is in the Bluegrass physiographic region. Heavy sediment loads and sewage effluent from urban centers have limited the aquatic biota from urban centers have limited the aquatic biota in this region. Silver Creek and South Elkhorn Creek have been particularly affected and aquatic communities in these streams are dominated by organisms tolerant of low dissolved oxygen concentrations. Biological data for other streams indicate that habitat and water quality conditions are favorable for most commonly occurring aquatic organisms. (USGS) W91-02232

EFFECT OF SEWAGE SLUDGE ON NUTRI-ENT AND TOXIC METAL CONTENT OF SOIL AND SELECTED CROPS GROWN ON TROPI-CAL SOILS.

Puerto Rico Univ., Mayaguez. Dept. of Agronomy

and Soils.

N. Cavallaro, and J. Villarrubia.

N. Cavallaro, and J. Villarrubia.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-240045/

AS. Price codes: A04 in paper copy, A01 in microfiche. Technical Completion Report, Puerto Rico Water Resources Research Institute, Mayaguez, August 1989. 51p, 29 tab, 24 ref. USGS Contract No. 14-08-0001-G1611. USGS Project G1611-03.

Descriptors: \*Land disposal, \*Municipal wastes, \*Puerto Rico, \*Sewage sludge, \*Sludge disposal, \*Water pollution effects, Crop yield, Oxisol, Soil types, Vertisol.

Application of municipal sewage sludge to agricul-tural land is one means of disposing of this materiturial land is one means of disposing of this material. In general, no important negative effects on either quality of fruit, grain, or forage was observed in this study involving two soil types (one Oxisol and one Vertisol) representing northwestern and southwestern Puerto Rico. Sorghum, pigeon pea (Vertisol site), and eggplant (Oxisol) were grown in field experiments using from 0 to 24 mg/ha of aged Ponce municipal sludge. Yields were determined and leaf, fruit, grain and soils were analyzed. Sludge tended to increase yields and increases in iron concentration in sorghum grain and zinc concentration in pigeon pea are seen and increases in iron concentration in sorghum grain and zinc concentration in pigeon pea are seen as positive effects on quality. Nickel content in-creased in the leaf tissue of the sorghum while it creased in the leaf tissue of the sorghum while it decreased in the eggplant fruit tissue. Positive effects on exchangeable bases, pH, and available phosphorus, copper, and zinc were seen for the soils, consistent with earlier findings on a Ultisol treated with the same type of sewage sludge. This sludge appears to be a useful amendment for agricultural crops in western Puerto Rico. (USGS) W91-02239

USE OF THE INDEX OF BIOTIC INTEGRITY TO ASSESS THE IMPACT OF LAND MANAGEMENT ACTIVITIES ON LOW ORDER STREAMS IN NORTHERN IDAHO. Idaho Univ., Moscow. Dept. of Fish and Wildlife. For primary bibliographic entry see Field 5G. W91-02242

STABLE ISOTOPE TRACERS OF NITROGEN SOURCES TO THE NEUSE RIVER, NORTH

North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
W. J. Showers, D. M. Eisenstein, H. Paerl, and J.

Rudek.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-235342/
AS. Price codes: A03 in paper copy, A01 in microfiche. North Carolina Water Resources Research Institute, Raleigh, Completion Report No. 253, (UNC-WRRI-253), May 1990. 28p, 16 fig, 4 tab, 56 ref, append. USGS Contract No. 14-08-0001-G1440. USGS Project No. G1440-02.

Descriptors: \*Isotope studies, \*Neuse River, \*Nitrates, \*Nitrogen, \*Path of pollutants, Algae, Cyanophyta, Cycling nutrients, Eutrophication, Fate of pollutants, Isotopes, Nonpoint pollution sources, North Carolina, Nuisance algae, Pollutant identification, Water pollution effects.

Stable nitrogen isotopic analyses were conducted on dissolved nitrate in surface water samples col-

lected over a two-year period from the lower Neuse River, North Carolina, to assess temporal variation of nitrate sources to the watershed. Ni-Neuse River, North Carolina, to assess temporal variation of nitrate sources to the watershed. Nitrate samples collected at the Raleigh and Durham Municipal Sewage Treatment Plants have nitrogen isotopic values in the +9 to +14/mil range. Nitrate samples collected from agricultural drainage areas in the lower portion of the Neuse River basin have nitrogen isotopic values in the +4 to +9/mil range. These nitrogen isotopic values correspond well to literature values published for point and nonpoint nitrate sources, respectively, and confirm that there is a well defined isotopic difference between point and nonpoint nitrate inputs to the Neuse River Basin. The nitrogen isotopic values of nitrate from the lower Neuse, which integrates the nutrient loading trends over the entire basin, show an annual cycle. Surface water nitrate during low discharge periods is isotopically enriched and is in the point range of +9 to +14/mil. Surface water nitrate collected during high discharge periods is isotopically depleted and is in the nonpoint source range of +4 to +9/mil. Over the entire annual hydrological cycle, surface water nitrate nitrogen range of +4 to +9/mil. Over the entire annual hydrological cycle, surface water nitrate nitrogen isotopic values are exponentially related to river discharge rate. This relationship suggests that a residence time delay factor in an intermediate resresulted time detay factor in an intermediate re-ervoir (groundwater, wetlands) plays an important role in the transfer of nonpoint source nitrate to the riverine system during the falling discharge (spring) period. The enhanced fertilizer loading in wet years during the critical spring period can influence the biological species succession and would therefore play a significant role in enhanc-ing nuisance algae bloom potential in late summer. ing nuisa W91-02244

IMPACTS OF URBAN WASTE ON SURFACE WATER IN OUAGADOUGOU AND BOBO-DIOULASSO. GURKINA FASO). (IMPACTS DES REJETS URBAINS SUR LES EAUX DE SURFACE A OUAGADOUGOU ET BOB-DIOU-LASSO (BURKINA FASO)).

Centre National de la Recherche Scientifique et Technologique, Ouagadougou (Burkina Faso). For primary bibliographic entry see Field 5B. W91-02369

LIMNOLOGY AND EUTROPHICATION OF BARRA BONITA RESERVOIR, S. PAULO STATE, SOUTHERN BRAZIL.

Sao Paulo Univ., Sao Carlos (Brazil). Escola de

For primary bibliographic entry see Field 2H. W91-02371

PHOSPHORUS CYCLE AND ITS SIGNIFICANCE IN THE EUTROPHICATION OF LAKE

Akademiya Nauk Armyanskoi SSR, Sevan. Hydrobiological Station.

R. M. Parparova.

Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 709-712, 1990, 3 tab. 7 ref.

Descriptors: \*Cycling nutrients, \*Eutrophic lakes, \*Eutrophication, \*Lake Sevan, \*Limnology, \*Phosphates, \*Phosphorus, \*Water pollution effects, Diffusion, Lake sediments, Organic compounds, Orthophosphates, Plankton, Pore water, Precipitation, Primary productivity, Sedimentation, Surface water, USSR, Vertical stratification.

Eutrophication of Lake Sevan caused by its artificial level lowering has resulted in sharp changes in the nutrient regime. Tributaries are rich in P, due to geological peculiarities of the lake basin, with orthophosphate the main form of P. There is a positive relation between yearly average concentrations of total P and orthophosphate. During the last 50 years input of P from the basin to Lake Sevan had a small increase, from 133 to 150 t/yr. (The content of P in snow and rain increased almost two-fold.) Almost half of the P of tributaries and rain water is orthophosphate. The P con-centration of the lake is determined by the concentration of its organic form to a much greater degree than in the river water. An increase in

#### **Group 5C—Effects Of Pollution**

vertical stratification of orthophosphate is an important consequence of eutrophication. Unlike many lakes, P in Lake Sevan consists mainly of dissolved forms. Mineral and organic compound dissolved forms. Mineral and organic compounds make up approximately equal parts of dissolved P. The concentration of P in pore water exceeds that of surficial water by 1-2 orders of magnitude. Internal processes (diffusion from bottom and sedi-Internal processes (unrusion from outom and seumentation) are the most significant components of the P budget; external components (tributaries and precipitation) are insignificant. Excess of P sedi-mentation over its diffusion from the bottom is not mentation over its diffusion from the bottom is not compensated by discharge from the lake basin. This has caused a decreasing P concentration in the lake for many years. Lowering of the level of the lake itself could destroy the P cycle. Under a decreasing mean depth more of the P store in the water column is sedimented. Eutrophication of the lake in conjunction with the lowering led to a relative increase of particulate P and consequent increase in sedimentation. Resuspension of particuincrease in sedimentation. Resuspension of particu-late matter as a result of lake lowering should also contribute to P sedimentation as a result of its sorption on resuspended particles. An increase of plankton primary production under a decreasing P concentration is a peculiarity of the eutrophication of Lake Sevan. Internal processes (sedimentation and diffusion from the bottom) should determine the P regime of the lake in the near future. (Sand-PTT) PTT) W91-02376

EUTROPHICATION OF NIGERIA'S LAKE

Benin Univ., Benin City (Nigeria). Dept. of Zoolo-

gy. A. B. M. Egborge. Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 793-802, 1990. 8 fig, 15 ref.

Descriptors: \*Enrichment, \*Eutrophication, \*Lim-nology, \*Nigeria, \*Nutrients, \*Reservoirs, \*Water pollution effects, Dissolved oxygen, Hydrogen ion concentration, Lake Asejire, Nitrates, Phosphates, Stratification, Water temperature.

Thirteen years after the inundation of the River Oshum to form Lake Asejire, the three phases of Condum to form Lake Assigner, the three phases of impoundment have been completed. An increase in nutrient levels, indicated by conductivity, progressed steadily until 1978. Five years later, although the general nutrient load was similar to that of 1978, its vertical distribution showed a stratification with more nutrients in the bottom strata. Be-tween 1978 and 1983 there were also significant increases in temperature, pH, and particularly phosphate, which showed a 200% increase over its phosphate, which showed a 200% increase over its 1975/76 levels. Increases in phosphate levels associated with marked decreases in nitrate-N and dissolved oxygen content are indications of a deteriorating lake environment. (Author's abstract) W91-02384

INFLUENCE OF CAGE REARING PISCICUL-TURE ON WATER QUALITY AND BOTTOM SEDIMENTS IN ARTIFICIAL LAKES. KNIPIBKS Vodokanalproject, Sofia (Bulgaria). Dept. of Scientific and Technological Research. V. Semov, and A. Kuntcheva. Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 875-879, 1990. 1 fig. 2 tab, 6 ref.

Descriptors: \*Artificial lakes, \*Bottom sediments, \*Carp, \*Fish farming, \*Lake sediments, \*Path of pollutants, \*Water pollution effects, \*Water polluion sources, Antonivanovtzi Dam, Bulgaria, Detritus, Hydrogen sulfide, Iron, Manganese, Nitrogen, Organic matter, Oxygen, Phosphorus, Water quality.

Studies were carried out on water quality and Studies were carried out on water quanty and bottom sediments in the Antonivanovtzi Dam in Bulgaria, where carp are reared in cages. During periods of maximum fish yield, the quantity of discharged organic matter as scattered (non-utilized) food is more than 1400 tons annually. The pollution impact of cage rearing pisciculture most distinctly affects the bottom sediments, leading to a significant increase in their oxygen uptake rates. The oxygen uptake by bottom sludges in the Antonivanovtzi Dam cage rearing farm zone, ex-

pressed in mg O2/1 gm dry sediment for a 24-hr pressed in mg O2/1 gm dry sediment for a 24-nr period, is 7.0, and by sediments in the upper part of the lake, outside the cage rearing zone, only 1.8 mg O2. The loss on ignition value, the total N, organic N and total P values, expressed in % of the dry sediments in the samples from the cage rearing zone, are respectively 13.70, 1.18, 0.78, and 0.47, against 10.37, 0.19, 0.14, and 0.07 in samples from the upper part of the lake. The raised consumption of oxygen at the bottom is the cause of anaerobic of oxygen at the bottom is the cause of anaerobic hypolimnion formation in the dam, starting in July and August, and lasting until the autumn vertical circulation of water begins. Within the rotting organic matter, under anaerobic conditions, hydrogen sulfide is formed, and accumulates in the bottom layers. Iron, manganese and phosphorus also change to soluble forms and accumulate in the water lawer, entering the circle of matter. With the water layer, entering the circle of matter. With the water layer, entering the circle of mater. With the biological equilibrium in the Antonivanovtzi Dam as a potential water supply source, it was recommended that cage rearing pisciculture be eliminated or reduced to a minimum. (Author's abstract)

WAYS OF EVALUATING HUMAN-INDUCED IMPACTS ON THE FUNCTIONING OF WA-TERBODY ECOSYSTEMS.
Institute of Ecology of the Volga River Basin,

Tolyatti (USSR).
For primary bibliographic entry see Field 4C.
W91-02397

GROWTH, PRODUCTION, AND DECOMPOSITION DYNAMICS OF SPHAGNUM UNDER NATURAL AND EXPERIMENTALLY ACIDIFIED CONDITIONS.

FIED CONDITIONS.
Alberta Univ., Edmonton. Dept. of Botany.
L. Rochefort, D. H. Vitt, and S. E. Bayley.
Ecology ECOLAR, Vol. 71, No. 5, p 1986-2000,
October 1990. 6 fig. 6 tab, 74 ref. Natural Sciences
and Engineering Research Council of Canada
grant A-6390.

Descriptors: \*Acid rain effects, \*Acidification, \*Decomposition, \*Mosses, \*Peat bogs, \*Plant growth, \*Primary productivity, \*Sphagnum, Acid rain, Acidic water, Canada, Environmental effects, Growth rates, Nitrates, Ontario, Peat, Sulfates, Water pollution effects.

Annular linear growth, net primary production, and decomposition of Sphagnum fuscum, Sphagnum magellanicum, and Sphagnum angustifolium were measured under experimental acidification and natural conditions in a poor fen at the Experiand natural conditions in a poor fen at the Experimental Lakes Area, Ontario, Canada. For the experiment, the mire received two treatments: a control area was sprayed with lake water only and an acidified area was sprayed with lake water plus strong acids to simulate acidic rain equivalent to a pH of 4.0. Acidification increased growth and production of most species (2 out of 3 in the oligotrophic zone, and 2 out of 3 in the minerotrophic zone) in the first 2 years. After 2-3 years of artificial acidification, growth and production were not stimulated to the same extent in experimental areas as in earlier years. After 4 years growth and sumulated to the same extent in experimental areas as in earlier years. After 4 years, growth and production in the experimental area declined so that they were the same as controls for 4 of the 6 treatments. Therefore, the effect of the acid treatment changed over the years. With 4-year simulated acid rain, decomposition was unaffected. Our results suggest that the fertilizing effect of SO4(2-) and NO3(-) in North American acid precipitation and very many the same as suggested previously in the literature is a very short-term one, a least for this type of peatland. Under natural conditions, in the oligotrophic central zone of the mire, production for hollow species was somewhat greater than for hummock species for the 4 years studied. Since the decor cies for the 4 years studied. Since the decomposi-tion rate ratio between hummock-top, mid-hum-mock, and hollow species is roughly in the ratio 7:9:13, the rate of peat accumulation should be higher in hummocks. Hence hummocks appear to be maintained in this poor fen due to low decom-position rates rather than relatively high produc-tion. The relative decomposition rates of the species in the minerotrophic edge zone had the same ratio as in the oligotrophic zone. Thus hummocks appear to be expanding in this minerotrophic edge

zone at a faster rate than in the oligotrophic zone. (Mertz-PTT)

ELEVATED ATMOSPHERIC CO2 EFFECTS ON BELOWGROUND PROCESSES IN C3 C4 ESTUARINE MARSH COMMUNITIES.

Smithsonian Environmental Research Edgewater, MD. P. S. Curtis, L. M. Balduman, B. G. Brake, and D. F. Whigham.

Ecology ECOLAR, Vol. 71, No. 5, p 2001-2006, October 1990. 4 fig, 1 tab, 26 ref.

Descriptors: \*Air pollution effects, \*Carbon dioxide, \*Climatic changes, \*Estuarine environment, \*Greenhouse effect, \*Marsh plants, \*Salt marshes, \*Wetlands, Air pollution, Cord grasses, Ecological effects, Growth rates, Marshes, Nitrogen, Roots, Sedore Sedore 1988.

Recent work on the responses of native perennial plants to elevated CO2 has begun to explain the ecological consequences of rising atmospheric CO2. It has been shown that plants have a wide range of aboveground morphological and physiological responses to high CO2. Belowground carbon allocation is a major component of a plant's carbon budget, yet relatively little is known about the response of roots to elevated atmospheric CO2. Three brackish marsh communities dominated by Three brackish marsh communities dominated by Three brackish marsh communities dominated by perennial macrophytes were exposed to twice ambient CO2 concentrations for two full growing seasons using open top chambers. One community was dominated by the C3 sedge Scipus olneyi, one was dominated by the C4 grass Spartina patens, and one was a mixture of S. olneyi, S. patens, and Distichlis spicata, a C4 grass. Root and rhizome growth were studied in the second year of exposure by measuring country into the second year of exposure by measuring country into seasons are second. growth were studied in the second year of expo-sure by measuring growth into peat cores previ-ously excavated and refilled with sphagnum peat devoid of roots. Growth under elevated CO2 re-sulted in an 83% increase in root dry mass per core in the Scirpus community. Those roots were also significantly lower in percentage of nitrogen than in the scirpus community. I nose roots were also significantly lower in percentage of nitrogen than roots from ambient-grown plants. There was no effect of elevated CO2 on root growth or nitrogen content in the Spartina community or in the C4 component of the mixed community. (Mertz-PTT) W91-02406

PREDATION ON AMPHIBIAN EGGS AND TADPOLES BY COMMON PREDATORS IN ACIDIFIED LAKES,

Goeteborg Univ. (Sweden). Dept. of Zoology. B. I. Henrikson. Holarctic Ecology HOECD2, Vol. 13, No. 3, p 201-206, August 1990. 3 tab, 43 ref.

Descriptors: \*Acid rain effects, \*Acidification, Descriptors: "Acid rain effects, "Aciditation, 'Amphibians, 'Eggs, 'Lake acidification, 'Larval growth stage, 'Predation, Acid rain, Acidic water, Aquatic insects, Dragonflies, Ecological effects, Frogs, Newts, Toads, Water beetles, Water boat-men, Water bugs.

During the last few decades, the large-scale acidification of surface waters has been shown to be a threat to amphibians inhabiting even non-agricultural areas. The negative impact of chemical changes to amphibian eggs and larvae such as low pH and high aluminum content is documented in both field and laboratory studies. In an attempt to determine potential predators on moor frog, Rana arvalis and common toad, Bufo bufo eggs in acidified lakes and the palatability of eggs and tadpoles researchers offered eggs and three different stages of premetamorphic tadpoles to the following potential predators in acidified lakes: newt Triturus vulgaris, water beetles Rhantus exoletus and Dytis-During the last few decades, the large-scale acidifivulgaris, water beetles Rhantus exoletus and Dytisvulgaris, water beetles Rhantus exoletus and Dytisicus Iapponicus, dragonfly larvae Leucorrhinia dubia and Aeshna spp., water boatman Notonecta glauca and water bugs, Cymatia bonsdorffi, Glaencorisa p. propinqua, and Corixa dentipes. The predation pressure on eggs of R. arvalis was low due to thick jelly. The eggs of B. bufo were not attractive to predators with chewing mouth parts due to unpalatability but predators with sucking mouth parts were not repulsed. Tadpoles of R. arvalis were eaten by all predators but tadpoles of

#### Effects Of Pollution-Group 5C

B. bufo were unpalatable to most predators. The predators used in the experiments are the new top predators in acidified fishless lakes. They may contribute to the reduction of populations of R. arvalis in acidified areas. (Mertz-PTT) W91-02407

PREMATURE THELARCHE IN PUERTO RICO: A SEARCH FOR ENVIRONMENTAL ESTROGENIC CONTAMINATION.

Centers for Disease Control, Atlanta, GA. Center for Environmental Health.

W. H. Hannon, R. H. Hill, J. T. Bernert, L.

Haddock, and G. Lebron. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 3, p 255-262, May 1987. 1 fig, 3 tab, 28 ref.

Descriptors: \*Chlorinated hydrocarbons, \*Hormones, \*Human physiology, \*Premature thelarche, \*Public health, \*Puerto Rico, \*Water pollution effects, Centers for Disease Control, Chemical analysis, Drinking water, Foods, Gas chromatography, Hormone supplementation, Laboratory methods, Mass spectrometry, Pesticides, Water analysis, Water pollution sources.

Premature thelarche is usually defined as breast development in girls below the age of eight years without other signs of premature sexual development. This condition is usually viewed as a variation in maturation or ovarian sensitivity, and is regarded as a benign condition that is not the beginning phase of a more serious problem. The etiology and population incidence are unknown. As part of an investigation into the cause of premature thelarche in Puerto Rico, the Centers for Disease Control (CDC) conducted various laboratory analyses to screen for estrogenic sources. Samples were obtained from case and control Samples were obtained from case and control households, children, parents, and environmental sources. Serum samples were analyzed from parents and children and household water samples for chlorinated hydrocarbons and no results were found above normal. Using gas chromatography/mass spectroscopy (GC/MS) procedures, serum was analyzed for zearalonol and its derivatives. Four case samples from the residual sample set rour case samples from the residual sample set were reported presumptively positive for zeara-lonol. Analyses of 96 case samples for estradiol, follicle-stimulating hormone (FSH) and luteinizing hormone (LH) yielded values within the normal reference range. The rat uterine cytosol-receptor assay was used as nonspecific screen for estrogenic assay was used as nonspecture. Screen for estrogenic activity. Two different contract laboratories used this assay to analyze milk, meat, poultry, and water samples collected from the households and local markets. The reliability of this assay was dependent upon the type of sample matrix. No significant difference between case and control samples were found with this screening process. (Author's abstract) W91-02429

ACUTE TOXICITY OF AQUEOUS AND SUB-STRATE-BOUND COPPER TO THE MIDGE, CHIRONOMUS DECORUS.

California Univ., Davis. Dept. of Land, Air and Water Resources

Water Resources.

P. Kosalwat, and A. W. Knight.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 3, p 275-282, May 1987. 4 fig, 3 tab, 33 ref. EPA Cooperative Agreement No. CR-808424 and Lawrence Livermore National Laboratory Intramural Order No. 4383305.

Descriptors: \*Bioassay, \*Biological magnification, \*Copper, \*Larvae, \*Midges, \*Toxicity, \*Toxicology, \*Water pollution effects, Bioconcentration factor, Chemical analysis, Chemical interactions, Chemical properties, Chemical speciation, Experimental data, Experimental design, Larval growth states Sylectores Water analysis. stage, Substrates, Water analysis

Fourth instar larvae of the midge, Chironomus decorus, were exposed to copper in water and copper in food and substrate (bound forms). Copper present in aqueous forms was more toxic than when it was present in bound forms. The relationship between copper in water and copper

in midges could be described by an exponential equation while the relationship between copper in substrate and midges was best described by a simple linear regression equation. Midge larvae accumulated copper from water and possessed some mechanisms to regulate copper uptake and excretion when exposed to copper concentrations of 0.05-1.0 mg/L (aqueous forms) and lost that ability when the concentration exceeded 1.0 mg/L. On the contrary, the midge larvae were unable to accumulate copper from food, since the estimated bioconcentration factor was between 0.10 and 0.16. When the midge larvae were exposed to copper in water, the uptake rate increased rapidly from 0-10 hr and then the rate increased very slowly or in some cases it reached a steady state after 10 hr. The steady state was attained within 1 to 3 hr when the midges were exposed to copper in food and substrate. (See also W91-02431) (Author's abstract) W91-02430

CHRONIC TOXICITY OF COPPER TO A PAR-TIAL LIFE CYCLE OF THE MIDGE, CHIRON-OMUS DECORUS.

California Univ., Davis. Dept. of Land, Air and Water Resources.

Water Resources.

P. Kosalwat, and A. W. Knight.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 3, p 283-290, May 1987. 5 fig, 1 tab, 33 ref. EPA Cooperative Agreement CR-808424 and Lawrence Livermore National Laboratory Intramural Order No. 4323206

Descriptors: \*Chronic toxicity, \*Copper, \*Eggs, \*Embryonic growth stage, \*Larvae, \*Larval growth stage, \*Midges, \*Sublethal effects, \*Teratogenic effects, \*Toxicity, \*Water pollution effects, Bioassay, Hatching, Incubation, Sediment contamination, Statistical analysis, Substrates.

A study was undertaken to evaluate the sublethal effects of sediment copper on the life history of the midge Chironomus decorus. The development and hatchability of C. decorus eggs were not affected by 0.1 to 5 mg/L of copper in water. The embryos developed normally and hatched at about the same time (after 55 hr of incubation). All larvae survived the duration of the test (72 hr) except those subjected to 5 mg/L of copper in water, which died time (anter 3 in o' inclusion). All larva's survived the duration of the test (72 hr) except those subjected to 5 mg/L of copper in water, which died after only partial emergence from the egg shell. Apparently, eggs were protected by their shell from copper. Growth of C decorus larvae was reduced significantly when they were reared in copper-spiked food-substrate (bound copper) from the age of 1 to 15 days old (900-4500 mg/kg of copper). The substrate copper concentration at which larval growth was reduced to 50% (EC50) was 1,602 mg/kg. Substrate copper caused deformities in the epipharyngeal plate of larval mouthparts and copper concentrations higher than 1800 mg/kg delayed adult emergence. The copper concentration in pupal exuviae and adults were positively correlated to copper concentrations in the substrate in which they had been reared as larvae. Larval stage appeared to be the most sensitive to copper toxicity, while eggs were the least sensitive tarval growth was the best indicator in detecting copper pollution, since it could detect copper at Larval growth was the best indicator in detecting copper pollution, since it could detect copper at relatively low concentrations. The time to adult emergence was not considered a very good indicator, while larval deformities offered a quick tool to evaluate copper pollution. (See also W91-02430) (Author's abstract)

TOXIC EFFECTS OF TETRAETHYL LEAD AND ITS DERIVATIVES ON THE CHRYSO-PHYTE POTERIOCHROMONAS MALHA-MENSIS: VIII. COMPARATIVE STUDIES WITH SURFACTANTS.

Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Botanik

G. Roderer.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 3, p 291-301, May 1987. 7 fig, 2 tab, 39 ref.

Descriptors: \*Algae, \*Algal growth, \*Chrysophyta, \*Cytology, \*Lead, \*Lethal limit, \*Organo-

metals, \*Surfactants, \*Toxicity, \*Toxicology, \*Water pollution effects, Algal physiology, Assay, Cytolysis, Flagellates, Germany, Lipids, Microtu-bules, Poteriochromonas malhamensis, Tetraethyl lead, Triethyl lead.

The toxic effect of triethyl lead (TriEL) on the phytoflagellate Poteriochromonas malhamensis (Chrysophyceae) was compared with those of eight surfactants some of which represent environmental pollutants. The surfactants typically inhibited algal growth and caused cytolysis in the concentration range from 12-310 microM. TriEl was cytolytic, similar to the surfactants, while lethal concentrations of increases and in the concentrations of increases and increases and in the concentrations of increases and in the concentration of increases and increases and in the concentration of increases and in the concentration of increases and in the concentration of increases and increase concentrations of inorganic lead did not cause cy-tolysis. It is postulated that this cytolytic effect was concentrations of norganic read tild not eause cytolysis. It is postulated that this cytolytic effect was mainly governed by combined hydrophobic and electrostatic interactions with the lipid phase of the membranes. The cationic and zwitterionic surfactants and sodiumdodecylaulfate (SDS) and TriEL selectively inhibited mitosis and cytokinesis of the alga and caused the formation of giant multinucleated cells, suggesting selective interaction on the algal microtubules (MTs). However, sodium-deoxycholate (DOC). Triton X-100 (TX100), and Triton X-405 (TX405) had no selective effects on these parameters. The most active surfactant, SDS, inhibited MT assembly in vitro and caused an instant and complete disassembly is applied to MTs that were preassembled without surfactant. TX 100, which was inactive in the algae, showed no effect in the in vitro MT assay, even is applied in ten times higher concentrations than SDS. The observations indicate that the surfactants did not act chaotropically on the alga's cell membranes and vations indicate that the surfactants did not act chaotropically on the alga's cell membranes and that not only TriEL, but also the active surfactants selectively interfered with MTs, resulting in their selective toxic action in P. malhamensis. (Author's abstract) W91-02432

TRIBUTYLTIN RETARDS REGENERATION AND PRODUCES DEFORMITIES OF LIMBS IN THE FIDDLER CRAB, UCA PUGILATOR. Rutgers - The State Univ., Newark, NJ. Dept. of Biological Sciences.

J. S. Weis, J. Gottlieb, and J. Kwiatkowski. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 3, p 321-326, May 1987. 4 fig, 1 tab, 23 ref.

Descriptors: \*Antifoulants, \*Crabs, \*Organotin compounds, \*Toxicity, \*Toxicology, \*Water pollution effects, Aquatic animals, Aquatic environment, Aquatic life, Crustaceans, Ecdysis, Hormesis, Marine animals, Marine environment, Marine

Treatment of fiddler crabs, Uca pugilator, with levels of tributyltin (TBT) as low as 0.5 micro g/L during limb regeneration resulted in a retardation of the regeneration groves. Limbs regenerated in the presence of TBT showed a variety of deformities, primarily a curved appearance. This was particularly apparent in regenerated chelae, in which the dactyl curved away from, rather than towards, the pollex. The number of setae was reduced in limbs that regenerated in TBT, compared to those that regenerated in clean sea water, which in turn had a reduced number of setae in comparison to intact limbs. The production of deformities in the regenerated limbs was the most sensitive response and is consistent with findings in other groups of organisms, in which TBT ings in other groups of organisms, in which TBT also produces morphological abnormalities. (Author's abstract) W91-02434

TOXICITY OF CHLORINATED BORNANE (TOXAPHENE) RESIDUES ISOLATED FROM GREAT LAKES LAKE TROUT (SALVELINUS

Michigan State Univ., East Lansing. Pesticide Research Center.

search Center.
J. W. Gooch, and F. Matsumura.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 3, p 349-355, May 1987, 3 fig., 3 tab, 33 ref. Michigan Sea Grant Program Grant No. NA84AA-D-SG045C.

#### Group 5C-Effects Of Pollution

Descriptors: \*Bioassay, \*Great Lakes, \*Insecticides, \*Lakes, \*Path of pollutants, \*Pesticide residues, \*Pesticide toxicity, \*Tissue analysis, \*Toxaphenes, \*Toxicity, \*Toxicology, \*Trout, \*Water pollution effects, Aquatic animals, Aquatic environment, Aquatic life, Fish, Laboratory methods, Water pollution, Water sampling.

Lake trout samples from the Great Lakes contain residues of a complex pattern of chlorinated bor-nanes similar to the insecticide toxaphene. These residues, although structurally similar to toxa-phene, are composed of a different profile of com-pounds than the analytical standard. Chlorinated bornane residues were isolated from tissues of bornane residues were isolated from tissues of Lake Michigan and Siskiwit Lake (Isle Royale) lake trout using a variety of purification techniques. Toxicity studies were conducted to determine the toxicological properties of the isolated residues in comparison to both technical material and the procedural standard. Static 24-hr acute and the procedural standard. Static 24-hr acute bioassays with mosquito larvae (Aedes egypti) demonstrated that the residues were as toxic as the toxaphene standard. Additionally, experiments per-formed on the picrotoxinin receptor of the GABA (gamma-aminobutyric acid)-chloride ionophore complex of the central nervous system revealed complex of the central nervous system revealed that the residues were very potent at the 35S-t-butylbicyclophosphorothionate binding site. Therefore, both non-specific and specific measures of toxicologic potency show that environmentally derived residues of toxaphene retain significant biologic activity. There is no trend for decreasing peologic activity. There is no trend for decreasing toxicity of toxachene residues for the period of 1982-85. Also, the residues found in samples from Siskiwit Lake were as toxic as those found in Lake Michigan. (Author's abstract) W91-02435

EFFECTS OF CHLORINATED BENZENES ON DIATOM FATTY ACID COMPOSITION AND QUANTITATIVE MORPHOLOGY: I. 1,2,4-TRICHLOROBENZENE.

Michigan Univ., Ann Arbor. Great Lakes Research Div.

L. Sicko-Goad, D. Lazinsky, J. Hall, and M. S.

Summons.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 5, p 629-637, September 1989. 7 fig, 1 tab, 31 ref. US EPA Grant No. R-810684.

Descriptors: "Benzenes, "Bioaccumulation, "Biological magnification, "Chlorinated hydrocarbons, "Diatoms, "Fatty acids, "Lipids, "Morphology, "Path of pollutants, "Structure-activity relationships, "Toxicity, "Toxicology, "Water pollution effects, Aromatic compounds, Correlation analysis, Experimental design, Lipophilicity, Octanol/water partition coefficients, Photosynthesis, Trichlorobenzenes.

It is believed that there is a correlation between the uptake of chlorinated hydrocarbons by organisms and their lipid contents. It has also been demonstrated that exposure to hydrophobic compounds may result in changes in fatty acid composition. A series of studies was undertaken to determine the effect of selected chlorinated benzenes on diatom effect of selected chlorinated benzenes on diatom effect of selected chlorinated benzenes on diatom. se of chlorinated hydrocarbons by organisms fatty acid composition and cell structure. This study hopes to determine that, under similar constudy hopes to determine that, under similar controlled environmental conditions, observed sensitivity parallels that predicted by environmental chemistry. Cells of the diatom Cyclotella meneghinana were exposed in a closed system to 0.245 ppm 1,2.4-Trichlorobenzene. Response to this chiorinated benzene was monitored over a period of 5 days by quantitative ultrastructure and fatty acid percent composition. Over the time period examined, 41 significant morphological changes and 12 significant changes in fatty acid composition were observed. Autophagic-like vacuoles were frequently observed, indicating lysis of cellular constituents. In general, there was an increase in the C20-5 fatty acid, which may be indicative of photosynthetic impairment, since this fatty acid probably substitutes for linolenic acid in diatoms. The most significant numbers of changes were observed after 8 hr of exposure to this lipophilic toxicant, and these changes occurred in membratoxicant, and these changes occurred in membra-nous organelles. It is suggested that the daily pho-toperiodic variation in lipid content of phytoplank-

ton may be an important consideration in evaluating effects of lipophilic toxicants. (See W91-02437 thru W91-02439) (Korn-PTT) W91-02436

EFFECTS OF CHLORINATED BENZENES ON DIATOM FATTY ACID COMPOSITION AND QUANTITATIVE MORPHOLOGY: II. 1,3,5-TRICHLOROBENZENE.

Michigan Univ., Ann Arbor. Great Lakes Re-search Div. L. Sicko-Goad, J. Hall, D. Lazinsky, and M. S.

Simmons.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 5, p. 638-646, September 1989. 7 fig, 1 tab, 29 ref. US EPA Grant No. R-810684.

Descriptors: "Benzenes, "Bioaccumulation, "Biological magnification, "Chlorinated hydrocarbons, "Diatoms, "Fatty acids, "Lipids, "Morphology, "Path of pollutants, "Structure-activity relationships, "Toxicity, "Toxicology, "Water pollution effects, Aromatic compounds, Correlation analysis, Experimental design, Lipophilicity, Octanol/water partition coefficients, Photosynthesis, Trichlorobenzenes.

It has been suggested that increased toxicity of more octanol-soluble compounds to unicellular green algae may be related either to the greater ability of these compounds to penetrate and damage the lipoprotein cell membrane or to overdamage the lipoprotein cell membrane or to over-all lipid content of the algae. Cells of the diatom Cyclotella meneghiniana were exposed in a closed system to 0.245 ppm 1,3,5-trichlorobenzene. Re-sponse of the diatom was measured by quantitative ultrastructure and fatty acid percent composition over a 5-day period. During that time, 28 signifi-cant morphological and 13 significant fatty acid percent composition changes occurred. Autopha-gic-like vacuoles were observed consistently through the sampling periods. In comparison with exposure to 1,2,4-trichlorobenzene, 1,3,5-trichlorobenzene exerts fewer effects in the parameters studied, and these effects were observed most frequently in membranous components during the initial eight hours of exposure. It is suggested that the amount of cellular lipid and the relative reactivity of the isomer are responsible for the ob-served effects. (See W91-02436, W91-02438, and W91-02439) (Author's abstract) W91-02437

EFFECTS OF CHLORINATED BENZENES ON DIATOM FATTY ACID COMPOSITION AND QUANTITATIVE MORPHOLOGY: III, 1,2,3 TRICHLOROBENZENE

Michigan Univ., Ann Arbor. Great Lakes Re-search Div.

L. Sicko-Goad, J. Hall, D. Lazinsky, and M. S.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 5, p 647-655, September 1989. 8 fig, 1 tab, 32 ref. US EPA Grant No. R-810684.

Descriptors: "Benzenes, "Bioaccumulation, "Biological magnification, "Chlorinated hydrocarbons, "Diatoms, "Fatty acids, "Lipids, "Morphology, "Path of pollutants, "Structure-activity relationships, "Toxicity, "Toxiciology, "Water pollution effects, Aromatic compounds, Correlation analysis, Experimental design, Lipophilicity, Octanol/water partition coefficients, Photosynthesis, Trichlorobenzenes. Descriptors: \*Benzenes, \*Bioaccumulation, \*Bio-

Cells of the diatom Cyclotella meneghiniana were exposed in a closed system to 0.245 ppm 1,2,3-trichlorobenzene. Response of the diatom was measured by quantitative ultrastructure and fatty acid percent composition over a 5-day period.

During that time, 35 significant morphological and
12 significant fatty acid percent composition

changes occurred. The most pronounced morphological change that occurred was a significant in-crease in lipid volume. In addition, changes were observed in vacuolar relative volume, suggesting that the tonoplast became more permeable. Fewer significant changes were observed in fatty acid percent composition upon exposure to this isomer.

However, there was a consistent increase in oleic acid (C18:1). The observed changes in morphological and fatty acid percent composition were uniformly distributed with time after the first hour of exposure. Results support the hypothesis that increased lipid stores alter the timing of response to lipophilic toxicants. (See W91-02436, W91-02437, and W91-02439) (Author's abstract) W91-02438

EFFECTS OF CHLORINATED BENZENES ON DIATOM FATTY ACID COMPOSITION AND QUANTITATIVE MORPHOLOGY: IV. PENTACHLOROBENZENE AND COMPARISON WITH TRICHLOROBENZENE ISOMERS.

Michigan Univ., Ann Arbor. Great Lakes Research Div.

L. Sicko-Goad, M. S. Evans, D. Lazinsky, J. Hall, and M. S. Simmons Archives of Environmental Contamination and

Toxicology AECTCV, Vol. 18, No. 5, p 656-668, September 1989. 12 fig, 1 tab, 28 ref. US EPA Grants No. R-810684 and R-812311.

Descriptors: \*Benzenes, \*Bioaccumulation, \*Biological magnification, \*Chlorinated hydrocarbons, \*Diatoms, \*Fatty acids, \*Lipids, \*Morphology, \*Path of pollutants, \*Structure-activity relationships, \*Sublethal effects, \*Toxicity, \*Toxicology, \*Water pollution effects, Aromatic compounds, \*Correlation public Experimental design Lipo-Correlation analysis, Experimental design, Lipophilicity, Octanol/water partition coefficients, Pentachlorobenzene, Photosynthesis, Trichloro-

Cells of the diatom Cyclotella meneghiniana were exposed in a closed system to 0.095 ppm pentachlorobenzene over a period of 5 days. Changes in fatty acid and morphological percent composition were monitored to determine the effect of the toxicant. The greatest morphological change observed was an increase in lipid volume. Most morserved was an increase in lipid volume. Most morphological changes occurred in the 1 hour and 5 day sampling periods. Few changes in morphological characteristics or fatty acid percent compositions were observed at eight hours, when the cells were in the dark. The C18:1 and C20:5 fatty acids were most variable with exposure to pentachlorobenzene. Results suggest that at sublethal doses, lipophilic toxicants exert effects that are biphasic. That is, immediately measurable effects are ob-served in the cells that include increases in storage products and changes in membranous organelles.

Long-term effects are postulated to be the result of mobilization of lipophilic toxicants that have partitioned into lipid stores and are more available when lipids are metabolized. Although pentachlorwhen inputs are metabolized. Atthough pentacino-obenzene has a higher octanol/water partition co-efficient, it appears to exert fewer cellular changes than any trichlorobenzene isomer. (See W91-02436 thru W91-02438) (Author's abstract) W91\_02439

SKELETAL DEFORMITIES IN SMALL-MOUTH BASS, MICROPTERUS DOLOMIEUI, FROM SOUTHERN APPALACHIAN RESER-VOIRS.

Georgia Cooperative Fishery and Wildlife Re-search Unit, Athens.

search Unit, Athens.
M. J. Van Den Avyle, S. J. Garvick, V. S. Blazer,
S. J. Hamilton, and W. G. Brumbaugh.
Archives of Environmental Contamination and
Toxicology AECTCV, Vol. 18, No. 5, p 688-696,
September 1989. 2 fig. 7 tab, 30 ref.

Descriptors: \*Animal pathology, \*Animal tissues, \*Appalachian Mountains, \*Black bass, \*Fish, \*Reservoirs, \*Water pollution effects, Aquatic animals, Aquatic invironment, Aquatic life, Bioindicators, Contaminant residues, Skeletal deformities.

Smallmouth bass (Micropterus dolomieui) popula-tions in two of five reservoirs sampled in the southern Appalachian Mountains contained high percentages of individuals with lordosis, kyphosis, or scoliosis. Deformities of the vertebral column occurred in several year classes and varied with fish size; they were absent in small fish, present in 25-30% of the fish 241-300 mm long, and then decreased in occurrence with increased length.

# Effects Of Pollution-Group 5C

Because environmental contamination is often responsible for high occurrences of deformed fish, whole-body concentrations of contaminants, bone development characteristics, and blood plasma concentrations of calcium and phosphorus in normal and deformed fish were measured and were compared with the results of fish from reservoirs where no deformed fish were found. Vertebrae were significantly weaker and more elastic in deformed that in normal fish, but biochemical properties of vertebrae were similar among the groups tested. Concentrations of pesticides and metals were not elevated in deformed fish, and concentrations of calcium and phosphorus in blood plasma Because environmental contamination is often retions of calcium and phosphorus in blood plasma were similar in normal and deformed groups. Most environmental contaminants that have been shown to cause fish deformities could be discounted as causative agents on the basis of these results; howcausative agents on the basis of these results; how-ever, the exact cause was not determined. Further attempts to diagnose the cause of the deformities were limited by the lack of background informa-tion on relationships among the bone development processes, types of stresses that cause deformities and types of bone tissue in fish. (Author's abstract) W91-02440

MICROCONTAMINANTS AND REPRODUC-TIVE IMPAIRMENT OF THE FORSTER'S TERN ON GREEN BAY, LAKE MICHIGAN-

1983. Fish and Wildlife Service, Green Bay, WI. Habitat Enhancement Field Office.
T. J. Kubiak, H. J. Harris, L. M. Smith, T. R.

1. J. Kubiak, H. J. Harris, L. M. Smith, T. R. Schwartz, and D. L. Stalling. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 5, p. 706-727, September 1989. 4 fig, 8 tab, 134 ref. Sea Grant Federal Grant No. NA84AA-D-00065.

Descriptors: \*Chlorinated hydrocarbons, \*Dioxins, \*Eggs, \*Green Bay, \*Hatching, \*Incubation, \*Lake Michigan, \*Nesting, \*Polychlorinated bi-phenyls, \*Population exposure, \*Water birds, \*Water pollution effects, Animal behavior, Animal populations, Aquatic animals, Aquatic environ-ment, Aquatic life, Birds, Great Lakes, Reproductive success, Terns, Toxicity.

For the 1983 nesting season, Forster's tern (Sterna forsteri) reproductive success was significantly impaired on organochlorine contaminated Green Bay, Lake Michigan compared to a relatively uncontaminated inland location at Lake Poygan, Wisconsin. Compared with tern eggs from Lake Poygan, eggs from Green Bay had significantly higher median concentrations of 2,3,7,8-tetrachlor-odibenzo-p-dioxin (TCDD), other polychlorinated dibenzo-p-dioxins (PCDDs), total polychlorinated biphenyls (PCBs), total (three congeners) non-ortho, ortho' PCBs, five individual PCB congeners known to induce aryl hydrocarbon hydroxylase (AHH) and several other organochlorine contaminants. Two PCB congeners, 2,3,3',4,4'-, and For the 1983 nesting season, Forster's tern (Sterna known to induce aryl hydrocarbon hydroxylase (AHH) and several other organochlorine contaminants. Two PCB congeners, 2,3,3',4,4'-, and 3,3',4,4'-, and 1,3',4,4'-, and 1,3',4'-, and 1,3',

TOXICITY TEST PROCEDURES FOR HYA-LELLA AZTECA, AND CHRONIC TOXICITY OF CADMIUM AND PENTACHLORO-PHENOL TO H. AZTECA, GAMMARUS FAS-CIATUS, AND DAPHNIA MAGNA.

Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences. For primary bibliographic entry see Field 5A. W91-02444

ACUTE TOXICITY OF INDUSTRIAL SURFACTANTS TO MYSIDOPSIS BAHIA.
AWARE, Inc., Nashville, TN.
W. S. Hall, J. B. Patoczka, R. J. Mirenda, B. A.
Porter, and E. Miller.

Torter, and E. Miller. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 5, p 765-772, September 1989. 2 fig, 3 tab, 17 ref.

Descriptors: \*Acute toxicity, \*Bioindicators, \*Crustaceans, \*Estuarine environment, \*Marine novironment, \*Toxicology, \*Water pollution effects, Aquatic animals, Ethylene oxide, Hazard assessment, Industrial wastes, Lethal limit, Solubility, Water pollutions converse.

The estuarine crustacean Mysidopsis bahia has been increasingly used to evaluate the toxicity of pure chemicals, effluents, and drilling muds in estuarine and marine environments. M. bahia is ecologically important due to its utilization as a major food source for bottom feeding fishes. A study was conducted to determine the acute toxicities of a variety of industrial surfactants to M. bahia and to variety of industrial surfactants to M. bahia and to gain some insight as to the importance of different chemical characteristics in influencing the toxicity of each surfactant. Three-day to eight-day old M. bahia were used to evaluate the acute toxicities of 17 industrial surfactants having a wide range of physicochemical characteristics. LC50s, based on physicochemical characteristics. LCSUs, based on nominal concentrations covered approximately three orders of magnitude (<1 to >4,000 mg/L). The base structure of the surfactants (i.e., aromatic, alipathic, branched, or linear) was not a factor controlling toxicity. Low solubility surfactants with low ethylene oxide (EO) molar ratios were the most toxic surfactants tested. Ethylene oxide chain length was the best predictor of toxicity, and would be a good parameter to use to screen for surfactant toxicity in hazard assessment. Substitu-tion of terminal OH with SO3 or PO4 reduced tion or terminal OH with SU3 or POA reduced toxicity of a selected group of surfactants. Sensitivity of M. bahia up to 26 days old was not significantly different from that of 3 to 8 day old animals. Use of one surfactant as a reference toxicant demonstrated that sensitivity of M. bahia was consistent throughout the various tests. (Author's abstract) stract) W91-02445

EFFECT OF WATER QUALITY ON BACTER-IOPLANKTON DENSITIES IN RIVER, BROOK AND PEAT MINING WATER IN THE BASIN OF THE HUMIC RIVER KIIMINKIJOKI, NORTHERN FINLAND.
Water and Environment District of Oulu (Fin-

iand). K. Heikkinen, and A. Visuri. Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 2, p 215-230, 1990. 2 fig, 5 tab, 52 ref.

Descriptors: \*Colloids, \*Microorganisms, \*Organic carbon, \*Rivers, \*Water pollution effects, Bacteria, Chemical properties, Finland, Humic substances, Iron, Phosphorus, Mining, Nitrogen, Peat, Peat bogs, Physical properties, Temperature effects, Water chemistry, Water temperature.

Total densities of suspended bacteria and physic Total densities of suspended oacteria and physico-chemical water quality parameters were studied in river, brook and peat mining water in the drainage basin of the humic Kiiminkijoki River in Finland. Bacterial densities ranged from 960,000 to 8,220,000 cells/ml, biomasses from 12 to 105 mcrogram C/L and cell volumes from 0.074 to 0.144 cu micrometers. Organic carbon in the bacterial biomasses accounted for 0.05-0.66% of total organ-ic carbon concentrations, 0.51-5.47% of particulate organic carbon and 0.06-0.83% of dissolved organ-ic carbon. Bacterial densities increased with water temperature. The results indicated that organic iron-phosphorus colloids were important for bactegrowth in these humic waters. Bacterial densi-in the river also increased with increasing

particulate organic carbon concentrations, but dissolved organic carbon alone had only a small influence on them. Microbial activity in the river was probably also limited by the low ammonium nitrogen concentrations. Bacterial growth in the peat mining water seemed largely to be controlled by detrital phosphorus content, and bacteria in bog iron-ore formation also seemed to be important. Concentrations of inorganic nitrogen, iron and phosphorus in filtrates and dissolved organic carbon, and also bacterial densities, increased in the river downstream of the neat production areas. the river downstream of the peat production areas.

The increased in bacterial densities in the area of Incircased in oacternal censities in the area of loading was probably mainly due to increasing concentrations of inorganic nitrogen and organic nitrophosphorus colloids. The increase in inorganic nitrogen concentrations could mainly be attributed to loading from the peat mining areas. (Author's abstract) W91-02455

INFLUENCE OF SEASON AND EXERCISE ON THE LETHAL TOXICITY OF CYANIDE TO RAINBOW TROUT (SALMO GAIRDNERD). Concordia Univ., Loyola Campus, Montreal (Quebec). Ecotoxicology Research Lab. S. M. McGeachy, and G. Leduc. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 3, p 313-318, May 1988. 2 fig. 4 tab, 27 ref.

Descriptors: \*Cyanide, \*Toxicity, \*Trout, \*Water pollution effects, Environmental effects, Exercise effects, Fish behavior, Seasonal variation.

The response of continuously exercised and non-The response of continuously exercised and non-exercised juvenile rainbow trout (Salmo gairdneri Richardson) to lethal levels (96-hour LC50) of cyanide was examined for different seasons of the year. Trout were acclimated to the 12 C test temperature for 3-4 weeks, under a 12 hour phototemperature for 3-4 weeks, under a 12 nour photo-period before being tested at different times of the year. In summer, there was no significant differ-ence of sensitivity between exercised and non-exercised trout. From summer to winter, the 96hour LC50 for exercised trout remained un-changed at 0.052 mg/L cyanide, while the LC50 of changed at 0.052 mg/L cyanide, while the LC50 of the non-exercised trout dropped significantly to 0.043 mg cyanide/L. The median survival times of the two groups of trout were the same in the summer, but in winter the exercised fish survived twice as long as the non-exercised fish. A longer acclimation period of the non-exercised trout from 4 weeks to 10 weeks during the winter increased resistance to cyanide. (Author's abstract) W91-02458

HISTOPATHOLOGY OF RAINBOW TROUT EXPOSED TO A BLEACHED KRAFT PULP MILL EFFLUENT.

Montreal Univ. (Quebec). Dept. of Occupational and Environmental Health.

C. M. Couillard, R. A. Berman, and J. C. Panisset. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 3, p 319-323, May 1988. 1 fig, 5 tab, 18 ref.

Descriptors: \*Fish, \*Histology, \*Pulp wastes, \*Toxicity, \*Trout, \*Water pollution effects, Bacteria, Environmental effects, Fins, Fish diseases, Gills, Water pollution.

The toxicity of an untreated bleached kraft pulp mill effluent was evaluated histopathologically, using rainbow trout. Gills, liver, kidney, spleen, using rainbow trout. Crills, liver, kidney, spieen, digestive tract, and skin were examined in a 96-hour LC50 acute test. Fish exposed to lethal concentrations of effluent had an extensive fusion of gill lamella. This lesion was also present in fish that survived the 96-hour LC50 acute test but to a that survived the 96-hour LC50 acute test but to a lesser extent. Trout exposed for 20, 40, and 60 days to sublethal effluent concentrations were also ex-amined. No lesions that could be attributed specifi-cally to the effluent were observed, but exposed fish had a higher incidence of fin necrosis and damaged gills than the unexposed fish after 40 and 60 days. Loss of resistance to bacterial pathogens may be a significant stress-related effect of this effluent in fish exposed for long periods to low concentrations. (Author's abstract)

# Group 5C-Effects Of Pollution

W91-02459

TOXICITY TESTING OF SUBLETHAL EF-FECTS OF DREDGED MATERIALS. Old Dominion Univ., Norfolk, VA. Applied Marine Research Lab.

Marine Research Lab.
R. W. Alden, A. J. Butt, and R. J. Young.
Archives of Environmental Contamination and
Toxicology AECTCV, Vol. 17, No. 3, p 381-389,
May 1988. 7 fig. 1 tab, 24 ref. U.S. Army Corps of
Engineers contract number DACW65-81-C-0051.

Descriptors: \*Dredging wastes, \*Hampton Roads, \*River sediments, \*Shrimp, \*Toxicity, \*Water pollution effects, \*Water pollution sources, Dredging, Elizabeth River, Path of pollutants, Pollution load, Virginia, Water pollution.

A series of toxicity tests were conducted on liquid and suspended solid phase fractions of sediments from the Port of Hampton Roads, Virginia. There were significant sublethal effects associated with exposure of the test organisms to fractions of sediments taken from certain stations in the Port of Hampton Roads. The respiration rates of the grass shrimp populations were depressed dramatically upon exposure to the liquid and suspended solid fractions of sediments from the most highly industrialized region of the Southern Branch of the Elizabeth River. Likewise, he hyporegulation capacity of grass shrimp exposed to high salinities declined following exposure to the elutriates from the same stations. The low levels of mortalities was apparently due to the removal of the most highly contaminated sediments by maintenance dredging operations 4-6 months prior to the tests. Lethal effects of the sediments were observed to return during tests 18 months following dredging. The sublethal effects of the sediments appear to be negligible in a region of the Southern Branch where the River makes a right angle turn and the sediments are somewhat sandy. The stations further upstream produced moderate sublethal effects, but only low levels of mortalities. The relative quality of the sediments which would be dredged during any future harbor depening operations appears to be quite good. The sublethal effects of sediments composited to a depth of 3m did not produce significant sublethal effects. The toxic agent(s) producing respiratory depression and diminishment of osmoregulation capacity is unknown, but previous investigations indicate that this type of sublethal response is not uncommon and may be produced by different types of pollutants. (Mertz-PTTT)

INORGANIC POLLUTION OF THE MAN-MADE LAKES OF WADI EL-RAIYAN AND ITS IMPACT ON AQUACULTURE AND WILDLIFE OF THE SURROUNDING EGYPTIAN DESERT.

Cairo Univ., Giza (Egypt). Faculty of Agriculture. For primary bibliographic entry see Field 5B. W91-02462

CHRONIC EFFECTS OF 2,2'-DICHLOROBI-PHENYL ON REPRODUCTION, MORTALITY, GROWTH, AND RESPIRATION OF DAPHNIA PULICARIA.

Minnesota Univ., Minneapolis. Dept. of Ecology and Behavioral Biology. S. D. Bridgham.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 6, p 731-740, November 1988. 7 fig. 4 tab, 28 ref. EPA Grant CR810775.

Descriptors: \*Daphnia, \*Polychlorinated biphenyls, \*Sublethal effects, \*Toxicity, \*Water pollution effects, Biological studies, Environmental effects, Water pollution.

Previous studies have shown toxic effects of polychlorinated biphenyls (PCBs) on aquatic life only in the microgram/L range, well above normal ambient concentrations. Daphnia pulicaria was isolated from Lake Erie and exposed to 50 ng/L to 10 microgram/L of 2,2'-dichlorobiphenyl (DCB) in lifetable and physiological studies. Reproduction,

mortality, growth, and respiration were measured for periods up to the entire lifespan of the animal with and without the use of an organic surfactant. One experiment was conducted for three generations of the daphnid continuously exposed to 2,2'-dichlorophenyl. Significant mortality and inhibition of reproduction were found at levels as low as 50-100 ng/L in lifetable studies, an no safe level could be determined. These are among the lowest levels ever reported for a PCB congener to cause significant biological effects. A unique, yet repeatable, dose-response curve occurred in lifetables with maximum inhibition at low to intermediate concentrations. Inhibition at the highest level tested, 10 microgram/L, occurred only after continuous exposure for three generations. Increasing concentrations of 2,2'-dichlorobiphenyl stimulated growth, while respiration experiments yielded variable results. (Author's abstract)

EFFECTS OF PULP MILL EFFLUENTS ON VERTEBRAE OF FOURHORN SCULPIN, MYOXOCEPHALUS QUADRICORNIS, BLEAK, ALBURNUS ALBURNUS, AND PERCH, PERCA FLUVIATILIS.

PERCH, PERCA FLUVIATILIS.

National Swedish Environment Protection Board,
Nykoeping, Brackish Water Toxicology Lab.

B. E. Bengtsson, A. Bengtsson, and U. Tjarnlund.
Archives of Environmental Contamination and
Toxicology AECTCV, Vol. 17, No. 6, p 789-797,
November 1988. 2 fig. 5 tab, 21 ref.

Descriptors: \*Fish diseases, \*Pulp wastes, \*Water pollution effects, Bleak, Environmental effects, Gulf of Bothnia, Perch, Sculpin, Sublethal effects, Sweden, Water pollution.

In 1980 and 1981, fourhorn sculpin, Myoxocephalus quadricornis, were sampled systematically in the Gulf of Bothnia (Sweden) to monitor skeletal deformation related to bleached kraft mill effuents. Elevated frequencies of deformation were found outside several industries and a thorough study at one industry verified a correlation between distance from the industry and incidence of spinal deformation. Current laboratory investigation with juvenile fourhorn sculpin, exposed for 4.5 months to four pulp mill effluents resulted in elevated frequencies of vertebral deformation. Vertebrae composition and mechanical strength were altered as a result of the treatment. The same aprameters were also altered for bleak, Alburnus alburnus, exposed for 3.5 months to the same effuents. The response pattern was, however, different and no vertebral deformation could be confirmed by X-ray technique. A field survey on feral perch, Perca fluviatilis, sampled in the vicinity of two kraft pulp mills with and without bleaching, on the Swedish east coast (Gulf of Bothnia) gave results similar to those obtained for bleak. Depleted ascorbate stores with subsequent disturbance in collagen metabolism is suggested as a possible mode of action. (Mertz-PTT)

SUBCLINICAL EFFECTS OF GROUNDWATER CONTAMINANTS. II. ALTERATION OF RE-GIONAL BRAIN MONOAMINE NEURO-TRANSMITTERS BY BENZENE IN CD-1 MICE.

MICE.

Utah State Univ., Logan. Dept. of Biology.

G. C. Hsieh, R. D. R. Parker, and R. P. Sharma.

Archives of Environmental Contamination and

Toxicology AECTCV, Vol. 17, No. 6, p 799-805,

November 1988. 1 fig. 3 tab, 32 ref. U.S. Geological Survey grant no. G-1255-04.

Descriptors: \*Benzene, \*Toxicity, \*Water pollution effects, Brain, Chromatography, Groundwater pollution, Health effects, Mice, Neurological effects, Sublethal effects, Water pollution.

Benzene, a common groundwater contaminant, possesses neurotoxic and behavioral effects. Male, adult CD-1 mice were continuously fed drinking water ad libitum containing 0, 31, 166 and 790 mg/L benzene for four weeks. Endogenous levels of the catecholamines norepinephrine and dopamine, the catecholamine metabolites 3-methoxy-4-hydroxymandelic acid, 3,4-dihydroxyphenylacetic

acid and homovanillic acid, and the indoleamine serotonin and it metabolite 5-hydroxyindoleacetic acid, were measured by high-performance liquid chromatography in six discrete brain regions. In the hypothalamus, the brain region richest in nore-pinephrine, concentrations of norepinephrine increased by 40% when mice received doses at 31 mg/L; 58% with 166 mg/L; and 61% with 790 mg/L. Significant increases of norepinephrine were also observed in the medulla oblongata and cerebellum. Dopamine concentrations increased significantly in the hypothalamus and corpus striatum. Increases of catecholamine metabolites were seen in a number of brain regions: midbrain (3,4-dihydroxyphenylacetic acid), corpus striatum (homovanillic acid, 3-methoxy-4-hydroxymandelic acid, and 3,4-dihydroxyphenylacetic acid), cerebral cortex (3-methoxy-4-hydroxymandelic acid, and cerebellum (3-methoxy-4-hydroxymandelic acid, and cerebellum (3-methoxy-4-hydroxymandelic acid). Benzene ingestion significantly increased serotonin concentrations in the hypothalamus, corpus striatum, midbrain, cerebral cortex and medulla oblongata. Concomitant with increases of serotonin, 5-hydroxyindoleacetic acid increased in corpus striatum, midbrain, cerebral cortex and medulla oblongata. Concomitant with increases of serotonin, 5-hydroxyindoleacetic acid increased in corpus striatum, midbrain, cerebral cortex and medulla oblongata. Concomitant with increases of serotonin, 5-hydroxyindoleacetic acid increased in corpus striatum, midbrain, cerebral cortex and medulla oblongata. Concomitant with increases of serotonin oblosm of the monoamine neurotransmitters investigated. (Author's abstract)

ENVIRONMENTAL EPIDEMIOLOGY OF NON-HODGKIN'S LYMPHOMA IN EASTERN NEBRASKA.

Nebraska Univ., Omaha. D. D. Weisenburger.

Neuronal of Industrial Medicine AJIMD8, Vol. 18, No. 3, p 303-305, 1990. 13 ref. Nebraska Department of Health Grant LB-506.

Descriptors: \*Cancer, \*Epidemiology, \*Ground-water pollution, \*Human diseases, \*Pesticides, \*Population exposure, \*Water pollution effects, Agricultural chemicals, Atrazine, Carbamate pesticides, Drinking water, Halogenated pesticides, Histology, Nebraska, Nitrates, Non-Hodgkin's Jymphoma, Organophosphorus pesticides, Phenoxy acid herbicides.

The incidence of non-Hodgkin's lymphoma (NHL) is increased in many counties in eastern Nebraska. Histologic analysis has revealed a twofold increase in the clinically aggressive, diffuse large cell subtype of NHL. To investigate the possible association between NHL and agricultural exposures, a population-based case-control study was conducted in eastern Nebraska in 1985. Telephone interviews were conducted with 201 men having histologically confirmed NHL and 725 controls. Among men, the use of the herbicide 2.4-D was associated with a 50% increased risk of NHL (OR 1.5, 95% CI 0.9, 2.4). Personal exposure to 2.4-D more than 20 days per year increased the risk threefold (OR 3.3, 95% CI 0.5, 22.1). Several classes of insecticides were also associated with increased risk: organophosphates (OR 1.9, 95% CI 1.6, 3.2), and chlorinated hydrocarbons (OR 1.4, 95% CI 0.8, 2.3). As a result of intense agricultural use, extensive contamination of shallow groundwater by nitrate and atrazine has also occurred in eastern Nebraska. A twofold increase of NHL is present in counties with greater than 20% of the wells contaminated by nitrate (>10 ppm) and in counties with intense fertilizer use. These findings suggest that NHL in eastern Nebraska may be related to the use of pesticides and nitrogen fertilizers. (Author's abstract) W91-02507

DRINKING WATER CONTAMINATION AND THE INCIDENCE OF LEUKEMIA: AN ECOLOGIC STUDY,

New Jersey State Dept. of Health, Trenton. Div. of Occupational and Environmental Health. J. Fagliano, M. Berry, F. Bove, and T. Burke. American Journal of Public Health AJHEAA, Vol. 80, No. 10, p 1209-1212, October 1990. 1 fig, 3 tab, 31 ref.

# Effects Of Pollution—Group 5C

Descriptors: \*Cancer, \*Drinking water, \*Epidemiology, \*Population exposure, \*Public health, \*Volatile organic compounds, \*Water pollution effects, Leukemia, New Jersey, Regression analysis, Trichloroethylene, Water pollution.

An ecologic study was performed to examine the relation between the incidence of leukemias and the occurrence of volatile organic chemical (VOC) contamination of drinking water supplies within a study area comprising subpopulations differentially exposed to drinking water VOCs (trichloroethylene and related solvents). Populations served by community water supplies were classified into exposure categories according to VOC contamination status based on 1984-85 sampling data. Leukemia incidence data (1979-1984) were collected from a population-based cancer registry. For females, the standardized incidence ratio was elevated only in towns in the highest of three exposure categories. No association was observed in males eu only in towns in the highest of three exposure categories. No association was observed in males in any of the exposure categories. A Poisson regression analysis of the data, using finer exposure strata, indicated an increased risk among females with increasing level of contamination which appeared to be distributed evenly across all age strata. The rate ratio for females at the highest exposure stratum for total nontributementaria. exposure stratum for total non-trihalomethane VOCs compared to the least exposed stratum was VOCs compared to the least exposed stratum was 1.68. The observed association appears to suggest that drinking water contaminated with VOCs may increase the incidence of leukemia among exposed females, but caution is advised in the interpretation of these results because of the uncertainties inherent in ecologic studies. (Author's abstract) W91-02509

EVALUATING THE IMPACT OF MUNICIPAL WATER FLUORIDATION ON THE AQUATIC ENVIRONMENT.

Lakeshore General Hospital, Pointe Claire (Quebec). Community Health Dept.

J. W. Osterman.

American Journal of Public Health AJHEAA, Vol. 80, No. 10, p 1230-1235, October 1990. 4 tab,

Descriptors: \*Drinking water, \*Environmental effects, \*Fluoridation, \*Fluorides, \*Path of pollutants, \*Water pollution effects, \*Water treatment, Canada, Environmental impact, Environmental quality, Montreal, Municipal treatment, Quebec, Rivers.

Although highly beneficial for dental health, low concentrations of fluoride in environmental waters may be toxic to several organisms. In an era of heightened public awareness about the environment, this may lead city officials to withhold implementing water fluoridation for environmental reasons. A mass balance approach was used to evaluate this perceived risk. Generally speaking, fluoridated water loss during use, dilution of sewage by rain and groundwater infiltrate, fluoride removal during secondary sewage treatment, and diffusion dynamics at effluent outfall combine to eliminate fluoridation-related environmental effects. In Montreal, water fluoridation would raise average aquatic fluoride levels in the waste water tects. In Montreal, water fluoridation would raise average aquatic fluoride levels in the waste water plume immediately below effluent outfall by only 0.05-0.09 mg/L. Downstream, these changes would be only 0.02-0.05 mg/L at 1 km, and 0.01 mg/L at 2 km below outfall. Overall river fluoride concentrations theoretically would be raised by 0.001-0.002 mg/L, a value not measurable by current analytical techniques. All resulting concentrations would be well below those recommended for environmental safety and would not exceed natural levels found elsewhere in Quebec. A literature review did not reveal any examples of municipal water fluoridation causing recommend-ed environmental concentrations to be exceeded, although excesses occurred in several cases of severe industrial water pollution. (Author's abstract) W91-02510

LEUKEMIA INCIDENCE AND RADIOACTIV-ITY IN DRINKING WATER IN 59 IOWA TOWNS.

Iowa Univ., Oakdale. Coll. of Medicine.

L. Fuortes, L. A. McNutt, and C. Lynch. American Journal of Public Health AJHEAA, Vol. 80, No. 10, p 1261-1262 October 1990. 2 tab, 7

Descriptors: \*Cancer, \*Drinking water, \*Epidemiology, \*Leukemia, \*Population exposure, \*Public health, \*Radium radioisotopes, \*Water pollution effects, Iowa, Radioactivity, Statistical analysis,

Fifty-nine towns in Iowa with single source drink-ing water were stratified on the basis of radium content in finished non-softened water to test the hypothesis of an association with total or acute myeloid leukemia. Fourteen towns had radium myeloid leukemia. Fourteen towns had radium concentrations in drinking water exceeding the EPA safety limit of 5 pCi/L. A small increasing trend existed for total leukemia with increased radium content in drinking water that is in accordance with either the hypothesis of no effect or of a small effect. Future study of cancer incidence and radium concentration in drinking water in these and other communities is needed to clarify the risk of leukemia secondary to naturally occurring Ra-226. (Author's abstract) 226. (Author's abstract) W91-02511

FREE AMMONIA AND TOXICITY CRITERIA IN A POLLUTED URBAN LAKE, Upstate Freshwater Inst., Inc., Syracuse, NY. For primary bibliographic entry see Field 5B. W91-02536

BREEDING BIOLOGY OF THE SPOTTED SALAMANDER AMBYSTOMA MACULATUM (SHAW) IN ACIDIC TEMPORARY PONDS AT CAPE COD, USA.
Cape Cod National Seashore, South Wellfleet, MA.
J. W. Portnoy.
Biological Conservation BICOBK, Vol. 53, No. 1, p 61-75, 1990. 1 fig, 3 tab, 32 ref.

Descriptors: \*Acid rain effects, \*Acidic water, \*Cape Cod, \*Ephemeral lakes, \*Hatching, \*Salamanders, \*Spawning, \*Water pollution effects, Biological studies, Hydrogen ion concentration, Lignin, Mortality, Organic acids, Survival, Tantager Capital Control of the Capital nins. Toxicity.

Many researchers have expressed concern that temporary ponds could be the most sensitive fresh-water bodies to atmospheric acidification because of isolation from inorganic soil buffers and direct exposure to both acidic rainfall and unbuffered exposure to both acidic rainfall and unbuffered snowmelt. The many temporary woodland ponds on Cape Cod appear especially vulnerable to acidification because of the low buffering capacity of local soils, the natural acidity from surrounding coniferous forest, and the low pH (4.0 to 5.0) of local precipitation. The relationship between water chemistry and breeding success of spotted salamanders (Ambystoma maculatum (Shaw)) was examined in temporary woodland ponds on outer Cape Cod, MA in 1985 and 1986. Most pond waters were dilute (median conductivity = 57 microm-bos/cm (1 micromhos/cm = 0.1 mS/m)), acidic Cod, MA in 1985 and 1986. Most pond waters were dilute (median conductivity = 57 microm-hos/cm = 0.1 mS/m)), acidic (median pH = 4.82), and highly colored (median = 140 Pt-Co units). Most acidity was due to abundant organic acids. Salamander survival to hatching was over 80% at 8 of 12 ponds monitored. Complete mortality, preceded by gross abnormalities, was observed only among embryos in the most acidic spawning pond (pH 4.3 to 4.5) in both years. Embryo transfers between ponds and laboratory studies indicated that reduced survival was due to the interaction of low PH with high tannin-lignin concentration. The use of amphibian embryonic survival to indicate acid rain effects is complicated by multiple habitat parameters and complicated by multiple habitat parameters and should only be attempted in conjunction with long-term population monitoring. (Author's abstract) W91-02550

S-OXYGENATION OF THIOBENCARB (BOLERO) IN HEPATIC PREPARATIONS FROM STRIPED BASS (MORONE SAXATILIS) AND MAMMALIAN SYSTEMS. California Univ., San Francisco. School of Phar-

J. R. Cashman, L. D. Olsen, R. S. Nishioka, E. S. Gray, and H. A. Bern

Gray, and R. A. Bern. Chemical Research in Toxicology CRTOEC, Vol. 3, No. 6, p 433-440, September/October 1990. 6 tab, 1 fig. 36 ref. NIH Division of Research Re-sources Grant FFD 1614 and California Department of Fish and Game Contract 8026

Descriptors: \*Bass, \*Biotransformation, \*Liver, \*Metabolites, \*Pesticide toxicity, \*Pesticides, \*Thiocarbamate pesticides, \*Water pollution effects, Bioassay, California, Cytochromes, Hogs, In vitro tests, Metabolism, Toxicity,

Since about 1975, the striped bass populations in the Sacramento Valley Delta (California) have experienced a sharp decline. Accompanying this decline is the striped bass die-off which may be linked to application of thiocarbamate herbicides such as the chemically persistent thiobencarb (Bolero). The in vitro S-oxygenation of thiobencarb (p-chlorobenzyl-N,N-diethylthiocarbamate) in caro (p-cniorodenzy)-N,N-dientylimocaromate) in the presence of hepatic microsomes from freshwa-ter and seawater-adapted striped bass was investi-gated. Thiobencarb S-oxide was the principal me-tabolite and accounted for 98% of the total thiotabolite and accounted for 98% of the total thio-bencarb metabolized by striped bass liver micro-somes. Studies on the biochemical mechanisms for striped bass hepatic S-oxygenation suggest that this reaction is catalyzed largely by the flavin-contain-ing monooxygenase and to a lesser extent by cy-tochromes P-450. Following the short incubation period used, no thiobencarb sulfone was detected and no evidence was found for a contribution of cooxidation in the S-oxidation of thiobencarb. This recedurion was superced by studies with periods. cooxidation in the S-oxidation of thiobencarb. This conclusion was supported by studies with microsomes and purified mammalian monooxygenases which also metabolized thiobencarb without cooxidizing factors. Highly purified cytochrome P-450IIB-1 S oxygenated thiobencarb more efficiently than highly purified hog liver flavin-containing monooxygenase. Thiobencarb S-oxide and thiobencarb sulfone were efficient carbamylating agents and reacted with thiol and amine nucleophiles, whereas thiobencarb itself was relatively stable to trans-thiocarbamylation. Monooxygenase-catalyzed S-oxygenation of thiobencarb by striped bass liver microsomes may represent a bioactivation process which could explain the known toxicity of thiobencarb in fish. (Author's abstract) W91-02552

ANALYTICAL APPROACH TO ASSESSMENT OF LONG-TERM EFFECTS OF LOW LEVELS OF CONTAMINANTS IN THE MARINE ENVI-RONMENT

Cambridge Univ. (England). Dept. of Zoology. For primary bibliographic entry see Field 5A. W91-02554

ASSESSMENT OF OCEAN WASTE DISPOSAL.
TASK 5. HUMAN HEALTH IMPACTS OF
WASTE CONSTITUENTS. II. PATHOGENS
AND ANTIBIOTICAND HEAVY METAL-RESISTANT BACTERIA.

Maryland Univ., College Park. Dept. of Microbi-

For primary bibliographic entry see Field 5E. W91-02616

LIMITATIONS TO THE UNDERSTANDING OF ION-EXCHANGE AND SOLUBILITY CONTROLS FOR ACIDIC WELSH, SCOTTISH, AND NORWEGIAN SITES.

Institute of Hydrology, Wallingford (England).
C. Neal, J. Mulder, N. Christophersen, M. Neal, and D. Waters.

Journal of Hydrology JHYDA7, Vol. 116, No. 1/4, p 11-23, August 1990. 1 fig, 21 ref.

Descriptors: \*Acid rain effects, \*Acidic water, \*Acidification, \*Aluminum, \*Land use, \*Norway, \*Scotland, \*Wales, \*Weathering, Cation exchange, Hydrogen ion concentration, Ion transport, Mathematical models, Soil water, Solubility, Water

# Group 5C-Effects Of Pollution

Predicting the consequences of atmospheric depo-sition and land-use changes such as conifer affores-tation/harvesting, for acidic and acid sensitive systerms, requires a thorough understanding of the interactions of major chemical, biological, and hydrological processes. Mathematical models depicting streamwater and lake water chemistry behavior are well established and have successfully deior are well established and have successfully de-picted short-term event streamwater data and his-torical acidification patterns for lake water. Among the hydrochemical mechanisms depicted in these models, emphasis is placed on ion-exchange and weathering reactions. A summary of soilwater and streamwater data from acidic catchments in Wales, Scotland, and Norway is presented. It is concluded that insufficient detail has been estab-lished to describe quantitatively the ion-exchange and weathering processes in determining streamand weathering processes in determining stream-water chemistry. Such a description is required before reliance can be placed on mathematical models describing short-term and long-term changes. The need for manipulative studies is highchanges. The need for manipulative studies is nignighted, emphasis being placed on minimizing perturbation of the system from field conditions. An appeal is made for the use of a standardized method for determining the exchangeable cations. The studies provide overwhelming evidence showing the incorrectness of the commonly used model-The studies provide overwhelming evidence showing the incorrectness of the commonly used modelling assumption that Al(OH)3 solubility determines inorganic aluminum levels in the soil and streams. The importance of simple mixing of soil and ground water, in explaining streamwater aluminum-hydrogen ion relationships, is emphasized. (Korn-PTT) W91-02735

ORIGINS OF ACID RUNOFF IN A HILLS-LOPE DURING STORM EVENTS.

Sveriges Lantbruksuniversitet, Umea. Dept. of Forest Site Research.

K. H. Bishop, H. Grip, and A. O'Neill. Journal of Hydrology JHYDA7, Vol. 116, No. 1/ 4, p 35-61, August 1990. 15 fig, 2 tab, 27 ref.

Descriptors: "Acid rain, "Acid streams, "Acid water, "Acidification, "Geochemistry, "Soil organic matter, "Soil water, "Storm runoff, Geohydrology, Groundwater, Hydrogen ion concentration, Hydrology, Slopes, Streamflow, Sweden.

Hydrology, Slopes, Streamllow, Sweden.

At the Svartberget Research Catchment in northern Sweden, stream pH had risen to 5.7 after a period of dry summer weather in 1987 before it dropped to below 4.4 during three ensuing storm events. To clarify the relationship between flow pathways and episodic acidity, the sources of storm runoff and its acidity in one of the catchment hillslopes were investigated. Hydrological considerations locate the origins of the runoff within the upper four decimeters of the soil in a swath some 50 m wide along the stream. Groundwater remained alkaline throughout the episodes. Increases in the total organic carbon content of runoff appeared to play a central role in the stream pH decline. The episode's acidity and distinctive chemical fingerprint originated in the runoff's passage through the organic-rich forest mor and/or streambank vegetation. Results from a columnicaching experiment supported this hypothesis. Such localized origins of runoff and especially of acidity may be of significance when calculating the rate at which acid episodes in other catchments acidity may be of significance when calculating the rate at which acid episodes in other catchments respond to changes in acid deposition. A better understanding of the interaction between runoff and organic material is needed to determine whether the acidity at Svartberget is natural or if it had been affected by atmospheric inputs of anthropogenic origin. (Author's abstract)

W91-02737

EVIDENCE FOR LONG-TERM DETERIORA-TION OF STREAMWATER CHEMISTRY AND SOIL ACIDIFICATION AT THE BIRKENES CATCHMENT, SOUTHERN NORWAY.

CATCHMEN1, SOUTHERN NORWAY.
Senter for Industriforskning, Oslo (Norway).
N. Christophersen, A. Robson, C. Neal, P. G.
Whitehead, and B. Vigerust.
Journal of Hydrology JHYDA7, Vol. 116, No. 1/
4, p 63-76, August 1990. 3 fig, 4 tab, 22 ref.

Descriptors: \*Acid rain, \*Acidic soils, \*Acidifica-tion, \*Calcium, \*Magnesium, \*Norway, \*Sulfates,

\*Water chemistry, Air pollution effects, Aluminum, Hydrogen ion concentration, Soil chemistry, Soil solution, Soil water, Statistical methods, Streams, Watersheds

In recent years sulfate concentrations in the fresh waters of southern Norway have declined, presumably owing to reduced atmospheric emissions of sulfur dioxide in Western Europe. There has also been a parallel decline in calcium and magnesium in fresh waters. An important question to be resolved is whether reduced base cation concentrasolved is whether reduced base cation concentra-tions can be explained predominantly as a response only to declines in sulfate levels, or whether con-current soil acidification also plays a role. To help clarify long-term trends in freshwater chemistry and potential soil acidification, an investigation, in which all major chemical species were considered, was conducted in the Birkenes catchment, south-ern Norway. Emphasis was placed on the choice of statistical tools and soil water data. For the period 1972, 1987 a steady decline was observed. of statistical tools and soil water data. For the period 1972-1987, a steady decline was observed for calcium (1.1-1.4 microeq/L/yr) and magnesium (0.6-0.8 microeq/L/yr) in streams at the Birkenes catchment. No similar significant trends were observed for other chemical species or for discharge over the whole record, but sulfate declined over the last two years of the study. The long-term deterioration of streamwater chemistry is ascribed to soil acidification in the catchment, which may offset the beneficial effects of reductions of anthropogenic sulfur deposition. Results from monitoring of soil solutions from 1984-1987 indicate that reductions of sulfate are accompanied by further reductions of base cations, but not of hydrogen ion and inorganic monomeric aluminum. (Korn-PTT) W91-02738

REVERSAL OF STREAM ACIDIFICATION AT THE BIRKENES CATCHMENT, SOUTHERN NORWAY: PREDICTIONS BASED ON POTEN-

THAL ANC CHANGES.
Senter for Industriforskning, Oslo (Norway).
For primary bibliographic entry see Field 5B.
W91-02739

ELEMENT BUDGETS OF TWO CONTRAST-ING CATCHMENTS IN THE BLACK FOREST (FEDERAL REPUBLIC OF GERMANY). Freiburg Univ. (Germany, F.R.). Inst. of Soil Sci-ence and Forest Nutrition. For primary bibliographic entry see Field 5B. W91-02740

PATHOGENIC MARINE VIBRIO SPECIES IN SELECTED NOVA SCOTIAN RECREATIONAL COASTAL WATERS.

Dalhousie Univ., Halifax (Nova Scotia). Faculty of Medicine. For primary bibliographic entry see Field 5B. W91-02780

OUTBREAK OF CAMPYLOBACTER ENTERI-TIS ASSOCIATED WITH A COMMUNITY WATER SUPPLY.

Centre Hospitalier Regional de la Beauce, Beauceville East (Quebec). Dept. de Sante Communau-

M. Alary, and D. Nadeau. Canadian Journal of Public Health CJPEA4, Vol. 81, No. 4, p 268-271, 1990. 1 fig, 1 tab, 22 ref.

Descriptors: \*Campylobacter, \*Enteric bacteria, \*Path of pollutants, \*Potable water, \*Public health, \*Water pollution effects, Chlorination, Coliforms, Contamination, Water quality.

In June 1987, an outbreak of acute enteritis oc-In June 1987, an outbreak of acute enteritis oc-curred over a period of two weeks in a small rural community where the potable water supply is un-filtered and unchlorinated. Campylobacter jejeuni was isolated from six patients. A case control study performed in a local fiberglass shop where workers clink a let of water should an association by drink a lot of water, showed an association be-tween the occurrence of enteritis and the consumption of ten or more 8 ounce glasses of water per day (Odds ratio = 6, p = 0.04). The attack rate of enteritis was 23.2% (13/56) and a dose response relationship was also noted (p = 0.05). C. jejeuni

was not recovered from the local water supply, which had temporarily been chlorinated the day before the samples were taken. However, samples taken just before the outbreak showed high coli-form counts. This episode suggests that unprotect-ed water systems may be contaminated by C. je-jeuni. (Author's abstract) W91-02781

DIFFERENCES BETWEEN FRESHWATER AND SEAWATER-ACCLIMATED GUPPIES IN THE ACCUMULATION AND EXCRETION OF TRI-N-BUTYLTIN CHLORIDE AND TRI-PHENYLTIN CHLORIDE.

Shiga Prefectural Inst. of Public Health and Envi-ronmental Science, Otsu (Japan).

T. Tsuda, S. Aoki, M. Kojima, and H. Harada. Water Research WATRAG, Vol. 24, No. 11, p 1373-1376, November 1990. 4 fig, 1 tab, 15 ref.

Descriptors: \*Antifoulants, \*Bioaccumulation, \*Bioassay, \*Bioconcentration, \*Fish physiology, \*Guppies, \*Organotin compounds, \*Trin-houtin chloride, \*Triphenyltin chloride, \*Water pollution effects, Chemical properties, Excretion, Freshwater, Path of pollutants, Seawater.

Differences between freshwater and seawater-acclimated guppies (Lebistes reticulatus) in the accumulation and excretion of tri-n-butyltin chloride (Bu3SnCl) and trephenyltin chloride (Ph3SnCl) were studied. The bioconcentration factors (BCF) of Bu3SnCl and Ph3SnCl reached plateau values after 7 and 10 days of exposure, respectively, in both types of fish. The BCF values of both Bu3SnCl and Ph3SnCl (460 and 110) in the freshwater fish were about twice as high as those (240 and 530) in the seawater-acclimated fish. The excretion rate of Ph3SnCl from the seawater-acclimated fish. mated fish (0.30/d) was about twice as rapid as that from the freshwater fish (0.13/d), but there was no difference between the fish in the rate for Bu3SnCl (0.35 and 0.32/d). These differences are probably due to the differences in the chemical properties and the physiological mechanisms employed by the fish for regulation of the osmotic pressure. (Author's abstract) W91-02793

ACID DEPOSITIONS, SUMMER DROUGHTS, FOREST DECLINE: DEVELOPMENT OF THE NITROUS ACID HYPOTHESIS.

Association pour la Prevention de la Pollution Atmospherique, Bordeaux (France).

Admisspace and Control of the Control of

Descriptors: \*Acid rain effects, \*Drought, \*Forest ecosystems, \*Nitrogen cycle, \*Nitrous acid, Anaerobic conditions, Climatic changes, Deforestation, Denitrification, Forest hydrology, Nitric acid, Nitrification, Organic matter, Soil bacteria.

The acidity of the organic layer and the underlying soils associated with most undisturbed forests provide edaphic conditions which are not conducive to autotrophic nitrification. The pattern of nitrogen to autotrophic nitrification. The pattern of nitrogen accumulation and retranslocation of nutrients in living biomass may be severely altered by anthropogenic activities such as deforestation; fertilization of podzolic forest soils; and industries, transportation vehicles, etc. inducing acid rain. The nitrous acid hypothesis could explain the triggering effect of drought on forest decline. The first rainfall after summer drought revivifies nitrifiers and so gives rise to an acidification push with nitric acid production. But also denitrifiers are rapidly revivified in anaerobic microsites. During this clirevivified in anaerobic microsites. During this cli revivined in anaerobic microsites. During this climatic event, intermediate NO2(-) of nitrification-denitrification (as undissociated HNO2 species) would react drastically and without discrimination on dead and living organic matter, thus altering roots and mycorrhizas, particularly in the direct vicinity of aggregates. (Fish-PTT) W91-02828

COMPARATIVE SURVEY OF IMPOSEX IN NORTHEAST PACIFIC NEOGASTROPODS

# Effects Of Pollution-Group 5C

(PROSOBRANCHIA) RELATED TO TRIBUTYLTIN CONTAMINATION, AND CHOICE OF A SUITABLE BIOINDICATOR.
Victoria Univ. (British Columbia). Dept. of Biol-

ogy. For primary bibliographic entry see Field 5A. W91-02894

OVERVIEW OF CASE STUDIES ON RECOVERY OF AQUATIC SYSTEMS FROM DISTURBANCE.

Minnesota Univ.-Duluth. Natural Resources Research Inst. For primary bibliographic entry see Field 5G. W91-02898

RECOVERY OF LOTIC PERIPHYTON COM-MUNITIES AFTER DISTURBANCE, Oak Ridge National Lab., TN. Environmental Sci-

ences Div. For primary bibliographic entry see Field 2H. W91-02899

RECOVERY OF LOTIC MACROINVERTE-BRATE COMMUNITIES FROM DISTURB-ANCE.

Georgia Univ., Athens. Dept. of Entomology. For primary bibliographic entry see Field 2H. W91-02900

ENVIRONMENTAL VARIATION, LIFE HISTORY ATTRIBUTES, AND COMMUNITY STRUCTURE IN STREAM FISHES: IMPLICATIONS FOR ENVIRONMENTAL MANAGEMENT AND ASSESSMENT.
North Dakota Univ., Grand Forks. Dept. of Biological Control of the Control of the Control of Control o

ogy. For primary bibliographic entry see Field 2H. W91-02901

ASSEMBLAGE STABILITY IN STREAM FISHES: A REVIEW.
Georgia Univ., Athens. School of Forest Re-

For primary bibliographic entry see Field 2H. W91-02904

EFFECTS OF OIL SPILLS ON MACRO-INVER-EFFECTS OF OIL SPILLS ON MACKO-INVER-TEBRATES OF SALTMARSHES AND MAN-GROVE FORESTS IN BOTANY BAY, NEW SOUTH WALES, AUSTRALIA. Sydney Univ. (Australia). Inst. of Marine Ecology. K. A. McGuinness.

Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 142, No. 1,2, p 121-135, October 2, 1990. 4 fig, 6 tab, 46 ref.

Descriptors: \*Botany Bay, \*Macroinvertebrates, \*Mangrove swamps, \*Oil spills, \*Salt marshes, \*Water pollution effects, Australia, Crustaceans, Ecological effects, Mollusks, Oil pollution, Recov-

In Botany Bay, Australia, salt marshes and manprove forests are not uncommonly threatened by oil spills. Studies were done to examine the short and long-term effects of spills on mollusks and crustaceans in these habitats, through simulation of crustaceans in these habitats, through simulation of an oil spill. Long-term effects were examined by following oiled patches in the experiment for 14 months, and by sampling areas which had been effected by spills 2 to 6 years earlier. Mortality of some species followed simulated spills but densities reached control levels within a few weeks. The reached control levels within a few weeks. The sampling of areas previously affected by spills also provided little, if any, evidence of long-term effects. There were few residual effects of the oil; therefore, recolonization would normally be relatively rapid, depending only on the size of the path affected and the rate of recruitment from the plankton. (Author's abstract) W91-02912

INFLUENCE OF WASTE WATERS FROM THE CITY OF VENICE AND THE HINTERLAND ON THE EUTROPHICATION OF THE LAGOON.

Venice Univ. (Italy). Facolta di Chimica Indus-B. Pavoni, A. Sfriso, R. Donazzolo, and A. A. Orio.

Science of the Total Environment STENDL, Vol. 96, No. 3, p 235-252, August 1990. 4 fig, 2 tab, 19

Descriptors: \*Eutrophication, \*Italy, \*Venice Lagoon, \*Wastewater pollution, \*Water pollution effects, Canals, Coliforms, Hydrogen ion concentration, Metropolitan water management, Nutrients, Oxidation-reduction potential, Salinity, Sewer systems, Wastewater facilities.

The unique location of Venice, Italy, built on a number of islands in the middle of a lagoon, has rendered it impossible, up to now, to construct an adequate sewage system. Most of the industrial and adequate sewage system. Most of the industrial and urban wastewaters from the hinterland are conveyed to treatment plants which have been progressively enlarged and improved; wastewaters from the city are discharged directly into the lagoon. Four seasonal samplings of lagoon waters were carried out during successive phases of high and low tide at stations located within Venice and its surroundings to monitor various physico-chemi-cal parameters (pH, redox potential, temperature), cal parameters (pH, redox potential, temperature), salinity, nutrient concentrations (nitrogen, phosphorus, carbon compounds) and bacteria (total coliform bacteria). Salinity was used as a parameter for estimating the hydrographic distance from the Adriatic Sea, and for grouping stations into five homogeneous areas. A negative correlation was found between salinity and the concentrations of nutrients. Gradients of increasing concentrations of nutrients were observed at increasing hydrographic distance from the sea. The contributions to eutrophication of fresh waters entering the lagoon from the hinterland and of wastewaters from the city have been estimated and found to be comparable. Some necessary interventions for the restoracity have been estimated and found to be compara-ble. Some necessary interventions for the restora-tion of the lagoon are: increasing the efficiency of the treatment plants; diverting the canal courses from the hinterland into closed ponds suitable for cultivatable of aquatic plants; enlarging and deep-ening the natural lagoon channels; and opening one or more small dam-regulated canals. Meanwhile, an adequate sewage system for the city of Venice has to be designed and built. (Author's abstract) W91-02930 W91-02930

ABSENCE OF CADMIUM IN THE BLOOD OF HORSES FED OATS GROWN ON MUNICIPAL SLUDGE-AMENDED SOIL.

For primary bibliographic entry see Field 5E. W91-02933

HYDROGEOLOGIC ASSESSMENT OF EXPO-SURE TO SOLVENT-CONTAMINATED DRINKING WATER: PREGNANCY OUT-COMES IN RELATION TO EXPOSURE. California Univ., San Francisco. Dept. of Epidemi-

ology and Biostatistics.

M. Wrensch, S. Swan, P. J. Murphy, J. Lipscomb,

Archives of Environmental Health AEHLAU, Vol. 45, No. 4, p 210-216, July/August 1990 2 fig, 4 tab, 11 ref.

\*California, \*Drinking water, \*\*Groundwater pollution, \*\*Statistical analysis, \*\*Teratogenic effects, \*\*Toxic wastes, \*\*Water pollution effects, \*\*Water pollution sources, \*\*Well water, Flow models, Leakage, Toxicity, Trichlor-

The California Department of Health Services conducted several studies to investigate community concerns that an alleged cluster of adverse pregnancy outcomes might result from exposure to drinking water from a single well that was contaminated by trichloroethane and traces of other chemicals leaked from an underground storage tank of a semiconductor manufacturing firm in the Los Paseos neighborhood of Santa Clara County, California. Earlier studies in 1980 and 1981 found statistically significant excesses of spontaneous abortions and birth defects in a presumably exposed area compared with an unexposed area. This second interview study in 1986 was conducted to

obtain information about the occurrence of these adverse pregnancy outcomes in an adjacent census tract that was presumed to have water exposure comparable to the originally studied area and to determine the occurrence of these outcomes in the original and new study areas after the contaminated well was closed in December 1981. Using quantitative methods to model movement of the solvent leak plume and water flow within the distribution system, it was estimated that women with adverse outcomes were no more likely to have received contaminated water than women with normal live births. The validity of this conclusion depends on the assumption that the two areas had comparable exposure. These results strengthen the hypothesis that exposure to water from the contaminated well were not responsible for the excess of adverse outcomes observed in the Los Paseos area. (Medina-PTT) W91-02935 obtain information about the occurrence of these W91-02935

IMPACT OF DISTILLERY EFFLUENT APPLI-CATION TO LAND ON SOIL MICROFLORA. National Environmental Engineering Research Inst., Nagpur (India).

A. Juwarkar, and S. A. Dutta. Environmental Monitoring and Assessment EMASDH, Vol. 15, No. 2, p 201-210, September 1990. 5 fig. 3 tab, 12 ref.

Descriptors: \*Bioindicators, \*Industrial wastes, \*Microorganisms, \*Toxic wastes, \*Wastewater utilization, \*Water pollution effects, Actinomyces, Effluents, Nitrogen fixing bacteria, Rhizobium, Soil bacteria, Soil fungi.

A pot culture experiment was conducted to evaluate the effect of different treatments of distillery wastewater mixed with domestic waste stabilization pond effluent (1:1) on populations of bacteria, fungi, actinomycetes, nitrogen fixing bacteria, and on the nodulation of groundnut plants. The results indicated that raw wastewater decreased the population of bacteria, fungi and actinomycetes. The growth rates of Rhizobium and Azotobacter were also reduced after raw wastewater application. The toxic effect of raw wastewater was minimized when it was mixed with stabilization pond effluent (1:1). This was demonstrated by an increase in the when it was mixed with standization pond effluent (1:1). This was demonstrated by an increase in the population of all microorganisms studied. When groundnut plant was irrigated with raw distillery wastewater, no fruits were produced and there was also less nodulation. Raw distillery water is therefore very toxic to soil microorganisms, which are fore very toxic to soil microorganisms which are important in the soil ecosystem. (Author's abstract) W91-02946

ALUMINIUM DEPOSITION IN BONE AFTER CONTAMINATION OF DRINKING WATER

Saint George's Hospital Medical School, London (England). Dept. of Cellular and Molecular Sci-

Elics.

J. B. Eastwood, G. E. Levin, M. Pazianas, A. P. Taylor, and J. Denton.

Lancet LANAAI, Vol. 336, No. 8713, p 462-464, August 25, 1990. 1 fig., 1 tab, 14 ref.

Descriptors: \*Aluminum sulfate, \*Drinking water, \*Water pollution, \*Water pollution effects, Bioaccumulation, Human physiology, Water pollution

Two healthy individuals who drank water accidentally contaminated at source with aluminum sulfate were investigated 6-7 months later. On July 6, 1988, at the Lowermoor water treatment works near Camelford, Cornwall, England, 20 tonnes of 8% aluminum sulfate solution were inadvertently deposited directly into a water tank (contact tank) instead of the storage tank. Because the contact tank was downstream from the pH monitors at the treatment works, the contaminated water was distributed. Shortly afterwards some of the 20,000 potential consumers noticed that the water had an unpleasant metallic taste and some manifested various symptoms. Water Al concentrations recorded at the time of the contamination ranged from 30 to 620 mg/L, levels that are well above the maximum admissable concentration of 0.2 mg/L given in the

#### Group 5C-Effects Of Pollution

EC Drinking Water Directive. The two individuals examined, claimed to have drunk the water at the time it was most heavily contaminated and the early symptoms of ulceration of the lip and mouth accord with mucosal damage resulting from the ingestion of an acidic, metallic solution. The bone biopsy findings of local areas of aluminum staining indicate a short period of increased gastrointestinal absorption of aluminum. During the pollution incident the aluminum was presurably in an abnormant staining in the pollution incident the aluminum was presurably in an abnormant staining the pollution incident the aluminum was presurably in an abnormant staining the pollution incident the aluminum was presurably in an abnormant staining the pollution incident the aluminum was presurably in an abnormant staining the pollution incident the aluminum was presurably in an abnormant staining the pollution incident the aluminum was presurably in an abnormant staining the pollution incident t dent the aluminum was presumably in an abnor-mally acidic medium so absorption was facilitated. maily acidic medium so absorption was facilitated. Aluminum absorption is also enhanced when the integrity of the intestinal mucosa is interrupted. These findings show that under certain conditions, normal individuals can absorb aluminum via the gut, and that such aluminum can be deposited in bone. (Author's abstract)

HEALTH EFFECTS OF CHEMICAL WASTE IN AN URBAN COMMUNITY.

Queensland Univ., Brisbane (Australia). Dept. of

M. P. Dunne, P. Burnett, J. Lawton, and B.

Medical Journal of Australia MJAUAJ, Vol. 152, No. 11, p 592-597, 1990. 6 tab, 27 ref.

Descriptors: \*Australia, \*Chemical wastes, \*Hazardous wastes, \*Public health, \*Urban areas, \*Water pollution effects, Human diseases, Morbidity, Mortality, Stress, Surveys, Toxicity.

ty, Mortaity, Stress, Surveys, Toxicity.

Results are given of a community health survey of people living near a hazardous chemical waste site in Kingston, Queensland, Australia. Compared with a matched control group, people near the site were no more likely to report serious diseases. Likewise, reports of cancer and mortality rates did not differ in the two groups. Kingston residents reported higher rates of symptoms of general poor health, high levels of stress and anxiety, and a higher incidence of miscarriages. The reports of poor physical health appeared to be independent of proximity to the hazardous waste site and duration of residence in the area. Symptom prevalence and perceived recent decline in health correlate most strongly with the stress and anxiety measures. While long-term investigation is necessary, it appears at this stage that the chemical waste is not associated with an increase in major diseases as associated with an increase in major diseases as reported by those who were interviewed. Health-wise, it is clear that the situation has had a negative impact. (Author's abstract) W91-02952

#### 5D. Waste Treatment Processes

BIODEGRADABILITY OF MONO- AND DIS-UBSTITUTED BENZENE-DERIVATIVES (ZUR BIOLOGISCHEN ABBAUBARKEIT MONO-UND DISURSTITUIERTER BENZOLDERI-VATE).

Hoechst A.G., Frankfurt am Main (Germany,

Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 23, No. 3, p 85-98, June 1990. 3 fig, 4 tab, 57 ref. English summary.

Descriptors: \*Aromatic compounds, \*Benzene, \*Biodegradation, \*Wastewater treatment, Analytical techniques, Decomposition, Degradation, Zahn-Wellens test.

The biodegradability of 161 mono-, and disubstituted benzene derivatives was determined using the static Zahn-Wellens test and compared with the results from other laboratories. The qualification of the test method is discussed as well as the valuation of the results following the course of testing. All of of the results following the course of testing. All of the monosubstituted compounds with only one ex-ception, proved to be biodegradable. The dependence of the biodegradability of the disubstituted benzene derivatives, as a function of type and position of the substituents, is discussed. From 141 compounds tested, 21 proved to be resistent against decomposition, while 32 derivatives exhibited prolonged acclimatization or degradation times. (AuW91\_02055

APPLICATION OF THE ANAEROBIC FLUID-IZED BED REACTOR FOR THE BIOLOGICAL WASTEWATER TREATMENT AT LOW TEM-PERATURES (ANWENDUNG DES ANAERO-BEN FLIESSBETTREAKTORS IN DER BIOLO-GISCHEN ABWASSERREINIGUNG BEI NIE-DRIGEN TEMPERATUREN).

chungsgesellschaft Joanneum G.m.b.H., Graz stria). Inst. fuer Oekosystemforschung und

Umweltmanagement.
C. Hayer, and H. M. Knoflacher.
Zeitschrift fuer Wasser - und Abwasser Forschung
ZWABAQ, Vol. 23, No. 3, p 106-113, June 1990. 4
fig, 7 tab, 31 ref. English summary.

Descriptors: \*Anaerobic digestion, \*Biological wastewater treatment, \*Fluidized bed process, Biological treatment, Chemical oxygen demand, Protozoa, Retention time, Temperature, Wastewater

Two anaerobic fluidized beds were tested with lab-scale equipment using synthetic wastewater. The experiments were designed to examine the effect of reduced temperatures in the fluidized bed (14 C and 18 C), low influent substrate concentration (mean soluble COD 405 mg/l; 30-580 mg/ SCOD) and short retention times (2.0 and 5.8 hours) on the efficiency of the anaerobic process. About 20-25% SCOD-reduction could be achieved at both tem-peratures and at organic loading rates as high. individual numbers of Histomonas meleagridis (SMITH) was observed. This flagellate was the only protozoan living in the two anaerobic fluidized beds. (Author's abstract) peratures and at organic loading rates as high as 0.12-0.86 kg/cu m COD/d. The variability of the

SIMPLIFIED OPTIMISATION PROCEDURE FOR FIXED BED ADSORPTION SYSTEMS. Queen's Univ., Belfast (Northern Ireland). Dept. of Chemical Engineering. G. McKay, and M. J. Bino. Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 1/2, p 33-41, May 1990. 10 fig, 4 ref.

Descriptors: \*Adsorption, \*Design criteria, \*Fixed bed adsorption, \*Optimization, \*Systems analysis, \*Wastewater treatment, Activated carbon, Flow rates, Liquid retention, Mercury, Phenols.

Selection of contacting and regeneration systems for granular activated carbon utilization in wastewater treatment processes is integrated. The operating line concept can be used to optimize a basic bed design to achieve the lowest cost. Once the operating line has been established, it is possible to called the complication of carbon exhaustion. ble to select the combination of carbon exhaustion rate and liquid retention time which give the optirate and liquid retention time which give the optimum or lowest-cost design. For a given system, in which liquid flow rate, impurity concentrations and carbon characteristics are fixed, the costs are dependent upon two primary variables: the carbon exhaustion rate, and the superficial liquid retention time. These two variables were determined for phenol, p-chlorophenol, and mercuric ions onto activated carbon in fixed bed systems. The effects of secondary process variables such as flow rate and the effect of percentage breakthrough show that for flow rates below 3.3 cu m/sec there is no significant gain in the carbon exhaustion rate by significant gain in the carbon exhaustion rate by reducing the flow rate. When the flow rate increased from 2.5 to 3.33 cu m/sec, the increase in carbon exhaustion rate is about 20%. The results have been used to predict optimum conditions for the systems based upon the C exhaustion rate and the systems based upon the C exhaustion rate and the empty bed residence time (EBRT). For a fixed EBRT, the carbon exhaustion rate is higher for lower percentage breakthrough required. For a fixed operating condition such as flow rate and pollutant initial concentration, the carbon usage rate reaches an optimum higher value corresponding to a minimum EBRT. (Brunone-PTT) W91-02081

LABORATORY MESOCOSM STUDIES OF FE, AL, MN, CA, AND MG DYNAMICS IN WET-LANDS EXPOSED TO SYNTHETIC ACID COAL MINE DRAINAGE.

Villanova Univ., PA. Dept. of Biology. R. K. Wieder, M. N. Linton, and K. P. Heston. Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 1/2, p 181-196, May 1990. 5 fig, 1 tab, 31 ref.

Descriptors: \*Acid mine drainage, \*Artificial wet-lands, \*Mesocosms, \*Wastewater treatment, \*Wet-lands treatment, Aluminum, Calcium, Cost analy-sis, Iron, Magnesium, Manganese, Mine wastes,

To evaluate the potential for constructed wetlands to treat acid coal mine drainage, six model wetland mesocosms (each 2.4 m by 15 cm) were filled with mesocosms (each 2.4 m by 15 cm) were filled with Sphagnum peat (15 cm deep), planted either with cattails (Typha latifolia) and living Sphagnum, living Sphagnum only, or left as bare peat (2 mesocosms per treatment). The model wetlands were exposed to synthetic acid coal mine drainage (pH 3.5, concentrations of iron, aluminum, manganese, calcium and magnesium ions of 78.8, 10.0, nese, calcium and magnesium ions of 7.8., 10.9, 5.2, 12.0 and 4.5 mg/L, respectively) at a rate of 90 ml/min, 6 hours/day, 5 days/week over a 16 week period. Chemical analyses of peat at periodic intervals indicated that the model wetlands were net sources of aluminum, manganese, calcium, and magnesium, but net sinks for iron. Type of vegetation had no significant effect on iron retention; of the 204 g of iron added to the model wetland systems, 162 g were retained. Formation of iron oxides accounted for 73 to 86% of the iron retention, with exchangeable iron contributing 0.2 to 1.2%, organically bound iron contributing 4 to 19%, and residual iron contributing 7 to 15% of total iron retention. Iron retention was greatest at the inflow ends of the model wetlands where iron retention appeared to reach saturation at a final iron concentration in the peat of 235 mg/g. At the rate of application of the synthetic acid mine drain-age, the model wetland systems would have ched an estimated complete iron saturation after 157 days. The mesocosm approach could be useful in generating site-specific data that can be applied to the formulation of cost-benefit analyses that can compare a proposed wetland treatment system with alternative conventional chemical methods for treating acid mine drainage. (Author's abstract) W91-02091

THERMOPHILIC CAMPYLOBACTERS IN TWO SEWAGE TREATMENT PLANTS IN LIBYA.

Lancaster Univ. (England). Inst. of Environmental and Biological Sciences.

M. Betaieb, and K. Jones

Letters in Applied Microbiology LAMIE7, Vol. 11, No. 2, p 93-95, August 1990. 1 tab, 16 ref.

Descriptors: \*Decontamination, \*Enteric bacteria, \*Libya, \*Pathogenic bacteria, \*Sludge digestion, \*Sludge drying, \*Wastewater facilities, \*Wastewater treatment, Filtered wastewater, Primary wastewater treatment, Sabratha, Secondary wastewater treatment, Stabilization ponds, Tripoli, Water quality monitoring.

Monitoring of thermophilic campylobacters in two Libyan sewage treatment plants has shown that the communities of Tripoli and Sabratha almost cercommunities of Tripon and Sabatha amost certainly harbor campylobacters capable of producing enteritis. The most probable number of thermophic ic campylobacters per 100 ml ranged between 3733 and 6277 in the primary sedimentation tanks at the two sewage treatment plants. The plant in Tripoli eradicated the campylobacters from effluent by secondary treatment with trickling filtration followed by chlorination. The plant at Sabratha, tollowed by chlorination. Ine plant at sabratina, which was not working well at the time of sampling, reduced campylobacter numbers by only 53% and 74% during secondary treatment in a stabilization pond. A reservoir in Sabratha, which received effluent from the stabilization pond and which well-ten used for invitational pond and which well-ten used for invitational pond partial. which supplies water for irrigation, also contained thermophilic campylobacters. In both treatment plants, campylobacters were eradicated from sewage sludge by digestion and drying. (Author's

# Waste Treatment Processes—Group 5D

GUIDELINES AND INTEGRATED MEASURES FOR PUBLIC HEALTH PROTECTION IN AG-

RICULTURAL REUSE SYSTEMS.

World Health Organization, Geneva (Switzerland). Div. of Environmental Health.

For primary bibliographic entry see Field 5E.

W91-02142

SELECTIVE ADSORPTION OF ARSENIC(V) ION BY USE OF IRON(III) HYDROXIDE-LOADED CORAL LIMESTONE. Kagoshima Univ. (Japan). Dept. of Applied Chem-

istry. S. Maeda, A. Ohki, Y. Tsurusaki, and T. Takeshita. Separation Science and Technology SSTEDS, Vol. 25, No. 5, p 547-555, April 1990. 6 fig, 1 tab, 8

Descriptors: \*Adsorption, \*Arsenic, \*Chemical treatment, \*Limestone, \*Wastewater treatment, Adsorption-desorption, Anions, Corals, Hydrogen ion concentration, Industrial wastewater, Iron, Phosphates.

In Japan, the arsenic level of water is regulated below 0.5 ppm in wastewater and 0.05 ppm in natural water. Accordingly, a treatment process is necessary to remove arsenic from industrial wastes in order to reduce its arsenic content below regulated values. By use of iron(III) hydroxide-loaded coral limestone (Fe-coral) as an adsorbent, a trace level of arsenic(V) ion in aqueous solution could be efficiently and selectively adsorbed onto the adsorbent surface. The arsenic adsorptibility of the Fe-coral depended upon the amount of iron(III) hydroxide loaded on the coral limestone. The arsenic adsorption was almost unaffected by the initial pH of the solution in the pH range 2-10, and was not practically influenced by the addition of such anions as chloride, nitrate, sulfate, perchlorate, and acetate in the aqueous solution. However, only coexisting phosphate caused a great depression in the arsenic adsorption. The arsenic adsorbed in contact with aqueous solution under a wide pH range (3.5-10). The arsenic adsorption was effectively applied to a column-type operation. (Author's abstract) In Japan, the arsenic level of water is regulated

HEAVY METAL DISTRIBUTION IN ANAERO-RIC SLUDGES

Universidad Complutense de Madrid (Spain). Dept. de Ingenieria Quimica. J. Tijero, E. Guardiola, M. Cortijo, and A. Diaz-

Barrionuevo. Separation Science and Technology SSTEDS, Vol. 25, No. 5, p 653-658, April 1990. 1 fig, 1 ref, 9

Descriptors: \*Anaerobic digestion, \*Digested studge, \*Heavy metals, \*Sludge analysis, \*Chemical analysis, Chemical composition, Copper, Effluents, Nickel, Sludge

The distribution of the heavy metals Cu, Ni and Zn in the different phases of the effluent proceeding from an anaerobic digester operating under complete mixture conditions was studied. Specifically, the heavy metal distribution between the solid sludge and supernatant liquid of the final effluent was measured. Cu retention was very high, 96-98%, and increases as the concentration in the effluent increases. An increase in Ni concentrahigh, 96-98%, and increases as the concentration in the effluent increases. An increase in Ni concentration in the effluent produces a decrease in the metal associated with the solid effluent, going from 92% for 5 mg/L to 81% for 30 mg/L. Some 90% of the Zn was retained in the solid sludges. Thus, small amounts of heavy metals remain in the clear liquid of the effluent. (Author's abstract) W91-02221

SOLVENT SUBLATION OF HEXACHLORO-AND

PHENOL.
National Tsing Hua Univ., Hsinchu (Taiwan).
Dept. of Chemistry.
K. Y. Shih, W. D. Han, and S. D. Huang.
Separation Science and Technology SSTEDS,

Vol. 25, No. 4, p 477-487, April 1990. 4 fig, 6 tab,

Descriptors: \*Chlorinated hydrocarbons, \*Separa-tion techniques, \*Solvent sublation, \*Solvents, \*Wastewater treatment, \*Water analysis, \*Water treatment, Air-water interfaces, Organic solvents, Surfactants, Volatile organic compounds.

Solvent sublation, a surface chemical separation method, has shown promise for the removal of method, has shown promise for the removal of certain types of organic compounds from aqueous systems. In the solvent sublation procedure, a surface-active (or volatile) solute is transported from the aqueous phase to an overlying layer of nonvolatile organic liquid on the air-water interfaces (or in the interior) of bubbles rising through the solvent sublation column. Hexachlorobutadiene (HCB) and 2,46-trichlorophenol were removed from aqueous solutions into passeffin ail by solvent. (HCB) and 2,4,6-trichlorophenol were removed from aqueous solutions into paraffin oil by solvent sublation. Over 99% of HCB was removed from a solution containing 100 ppb HCB initially in 10 min. The rate of removal of HCB by air stripping is somewhat slower than that by solvent sublation. The effects of added salt and ethanol on solvent sublation and air stripping of HCB were studied. About 64% of 2,4,6-trichlorophenol (TCP) were removed by solvent sublation from a solution containing 50 ppm 2,4,6-trichlorophenol initially at pH 1.84 for a 1 hour run. The rate of removal of 2,4,6-trichlorophenol can be improved by adding the cationic surfactant, hexadecyltrimethylammonium formide (HTA). As high as 95% of 2,4,6-trichlorophenol was removed in 1 hour if 10 ppm HTA was added to the solution before solvent sublation runs. (Hoskin-PTT) W91-02403

HAZARDOUS WASTE MINIMIZATION: SOURCE REDUCTION ALTERNATIVES IN THE AEROSPACE INDUSTRY.

CH2M Hill, Milwaukee, WI. H. G. Allerton.

Journal of Environmental Health JEVHAH, Vol. 53, No. 1, p 28-29, July/August 1990. 1 tab, 3 ref.

Descriptors: \*Aerospace industry, \*Hazardous waste disposal, \*Hazardous wastes, \*Industrial wastes, \*Waste reduction, \*Waste treatment, Cyanide, Halogenated wastes, Heavy metals, Solvents, Waste identification, Waste minimization.

Aerospace industry research and manufacturing operations generate a diverse spectrum of chemical wastes. A cooperative effort by three major aerospace companies and the California Department of Health Services successfully identified alternatives for hazardous waste minimization. A priority was given to source reduction alternatives that would given to source reduction alternatives that would allow the generator to cost-effectively maximize on-site activity to reduce liabilities associated with off-site waste disposal. Study coordinators devel-oped a standard data reporting form to collect hazardous waste generation and disposal informa-tion from a majority of the three companies' re-search and manufacturing operations located in southern California. Waste streams were then cor-pulated with the processor of activities responsible souriern Cantorna. waste streams were tinen cor-related with the processes or activities responsible for generating the wastes. Candidate waste streams were evaluated with respect to on-site treatment methods that have either been applied in other industries or have eitner been applied in other industries or have recently become commercially available. Available off-site treatment methods were identified and summarized for commercial treatment, storage and disposal facilities that carry out recycling, destruction or treatment of the types of waste streams covered in the study. The following water stream cateories were targated for proof waste streams covered in the study. The following water stream categories were targeted for potential waste minimization: spent halogenated solvents, ferric chloride solutions, photodeveloping solutions, water soluble coolants and cutting oils, cyanide plating solutions, heavy metal waste treatment sludges, noncyanide plating/etching/stripping solutions, plating in cleaning solutions, and lab pack miscellaneous wastes. These waste streams, typical of the aerospace industries' operations, represent more than 90% of the total volume of hazardous waste generated by the participant companies. (Mertz-PTT) W91-02411

WASTEWATER TREATMENT, THE UTILIZA-TION OF EARTH MATERIALS AS COAGU-

Cleveland State Univ., OH. Dept. of Geological

Journal of Environmental Health JEVHAH, Vol. 53, No. 2, p 22-25, September/October 1990. 8 fig.

Descriptors: \*Coagulation, \*Materials testing, \*Municipal wastewater, \*Wastewater treatment, Activated carbon, Basalts, Carbon, Granites, Limestone, Organic carbon, Pretreatment of stone, Organic carbon, Pretreatment of wastewater, Raw wastewater, Shales, Turbidity, Wastewater, Zeolites.

Removal of total organic carbon and total suspended solids are major concerns in municipal wastewater treatment. The effects of several earth materials, at varying dosages, were investigated as potential coagulants and compared to activated carbon and fly ash. Wastewater samples were collected from the city of Painesville Pollution Control Plant in Painesville, OH and from the Central Wastewater Teatremes Plant in Solar OH. Each wastewater Treatment Plant in Solon, OH. Earth materials used for coagulation study were granite, basalt, shale, limestone and zeolite. Dosages used were 0.4, 1.0, 2.0, 4.0, and 6.0 g/L. For each of the coagulants tested, total organic carbon concentra-tions were lower in wastewaters containing coagutions were lower in wastewaters containing coagu-lants than in the untreated wastewater, and the difference was more pronounced in the primary wastewater samples. Limestone was most efficient for primary effluent, while granite worked best for secondary effluent. Zeolite was most effective in removing sodium, calcium, and magnesium. Use of earth materials in the coagulation of municipal wastewaters at various degrees of pretreatment also increased the turbidity of wastewater. Powdered activated carbon effectively removed turbid-ity in the raw wastewaters and primary effluent, as well as effectively removing total organic carbon from wastewaters. (Mertz-PTT) W91-02412

INNOVATIVE SLUDGE DRYING

Camp, Dresser and McKee, Inc., Bradenton, FL. J. A. Banks, and W. K. Lederman. Public Works PUWOAH, Vol. 121, No. 10, p 112, 134, September 1990. 1 fig.

Descriptors: \*Sand filters, \*Sludge drying, \*Sludge filters, \*Wastewater treatment, \*Wastewater treatment facilities, Cellular confinement system, Florida, Gravity filters, Percolating filters, Sludge

da, Gravity filters, Percolating filters, Sludge.

Dewatering sludge at wastewater treatment plants has traditionally been a major operational concern. Smaller facilities rely on the sand filter drying bed for sludge dewatering. The sludge is applied to a graduated sand/gravel media. The water separates from the solids in the sludge via gravity and percolates down through the media. The water filter's upper layers are of a finer material to filter out the solid particles of the liquid sludge. Removing dried sludge from sand filter drying beds can be a problem because small tractors or loaders cannot operate on the loose soils of a conventional sand drying bed. Because of this, past methods used to clean the beds have included hand labor and various forms of mechanical devices that are not directly supported by the sand structure. In Florida, the Sarasota County-Solid Waste Operations Division had a problem with its fixed-mechanical, vacuum sludge-drying beds, which were used to dewater a chemically oxidized septage sludge. The fixed media material deteriorated under constant use and replacement was very expensive. A product, replacement was very expensive. A product, known as the cellular confinement system, had known as the cellular confinement system, had been developed specifically to support vehicular traffic over poor soil conditions. In September 1989, a cellular confinement system was installed in the top sand layer in one of the two sand filter drying beds at the Sarasota facility. Since installing the cellular confinement system, no change was noticed in the filter bed's drying efficiency compared to it other bed without the cellular confinement system. ment system. Clean-up operations have been exten-sively improved, even beyond that of the original

# **Group 5D—Waste Treatment Processes**

fixed-media filter bed. In April 1990, the waste operations division converted its second fixed-media filter bed to a sand filter bed reinforced with the cellular confinement system to further increase the efficiency of its operation. Through this system, maintenance costs have been cut by 50%. (Mertz-PTT)

SURVEY OF SMALL SEWAGE TREATMENT FACILITIES IN OHIO.
Ohio State Univ., Columbus. Dept. of Agricultural

Engineering. K. Mancl.

Ohio Journal of Science OJSCA9, Vol. 90, No. 4, p 112-117, September 1990. 9 fig, 11 ref, append.

Descriptors: \*Ohio, \*Surveys, \*Wastewater facili-ties, \*Wastewater management, \*Wastewater treat-ment, Aerobic treatment, Data acquisition, Per-mits, Site selection, Urban areas.

In 1987, a small sewage treatment facilities survey was conducted of all county and local health departments in Ohio. The objective was to learn how local sewage treatment facilities programs are managed, the types of systems in use, the numbers of permits issued, and the number of systems that are failing. Survey results indicate that urban areas in Ohio have the largest health departments and account for the largest number of permits issued, with over 13,000 permits issued in 1986. Site evaluation procedures varied greatly across the state. with over 13,000 permits issued in 1986. Site evaluation procedures varied greatly across the state. In 25 counties, permits were issued without a visit to the site. Sanitarians estimated that 27% of the septic systems are failing. Aerobic systems are used heavily in Ohio, while alternative systems have limited use. To address the problems of failing systems and unsuitable sites for septic systems, more information is needed at the county level about alternative swape systems and on-site. about alternative sewage systems and on-site system management. (Author's abstract) W91-02532

EFFECIS OF WASTEWATER TREATMENT AND SEAWATER DILUTION IN REDUCING LETHAL TOXICITY OF MUNICIPAL WASTEWATER TO SHEEPSHEAD MINNOW (CYPRINODON VARIEGATUS) AND PINK SHRIMP (PENAEUS DUORARUM).

Environmental Research Lab.-Narragan

Environmental Research Lab.-Narragansett, Newport, OR, Pacific Div. D. R. Young, D. J. Baumgartner, S. C. Snedaker, L. Udey, and M. S. Brown. Research Journal of the Water Pollution Control Federation JWPFA5, Vol. 62, No. 6, p 763-770, September/October 1990. 1 fig. 5 tab, 40 ref. FDA Grants R-804749 and R-806307, and EPA Contract 62 02.1706.

Descriptors: \*Killifish, \*Marine animals, \*Mortality, \*Municipal wastewater, \*Shrimp, \*Wastewater treatment, \*Water pollution control, \*Water pollution tion effects, Activated sludge, Chlorination, Floc-culation, Florida, Population exposure, Primary wastewater, Secondary wastewater treatment, Toxicity, Wastewater dilution.

The effects of treatment and seawater dilution of The effects of treatment and seawater diution of ununicipal wastewater on marine organisms were determined at an experimental facility in southeast Florida that provided both unchlorinated and chlorinated effluent from three standard treatments: primary settling, chemical flocculation, and activated sludge secondary treatment. Exposure tests lasting longer than one month were conducted on the sheepshead minnow (Cyprinodon variegatus) and the pink shrimp (Penaeus duorarum), with each of these six effluent twees at seawater. with each of these six effluent types at seawater dilution ratios of 30:1, 100:1, and 300:1. The shrimp showed a much more sensitive response than the minnow. Almost 100% mortality occurred for shrimp exposed to the unchlorinated 30:1 seawater dilutions of primary-settled wastewater, while mortality for the other two effluents was similar to that of controls. Mortality could not be attributed that of controls. Mortality could not be attributed to any of the chemicals measured in the wastewater. For the 30:1 dilution experiments, chlorination usually resulted in much higher toxicity; increasing the dilution factor from 30:1 to 100:1 reduced the mortality observed (in both chlorinat-

ed and unchlorinated samples) essentially to control levels. Little bioaccumulation of metals or chlorinated organics was observed in exposed specimens. (Author's abstract)
W91-02535

INTERACTION BETWEEN SULFATE REDUCERS AND METHANOGENS FED ACETATE AND PROPIONATE.

AND PROPIONATE.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
G. F. Parkin, N. A. Lynch, W. C. Kuo, E. L. Van Keuren, and S. K. Bhattacharya.
Research Journal of the Water Pollution Control Federation JWPFA5, Vol. 62, No. 6, p 780-788, September/October 1990. 7 fig. 5 tab, 27 ref. U.S. EPA Contract R-811657-01-0.

Descriptors: \*Acetates, \*Anaerobic digestion, \*Methane bacteria, \*Propionate, \*Sulfates, \*Sulfur bacteria, \*Wastewater treatment, Anaerobic bacteria, Biological treatment, Biological wastewater treatment, Chemostats, Organic loading, Sulfides.

Anaerobic chemostats maintained at solids retention times of 15, 25, and 40 days were used to investigate the interaction between sulfate-reducing bacteria (SRB) and methane bacteria fed accteria and propionate. Organic loading rates of 0.25-0.50 g COD/L-d were used with feed COD/S ratios ranging from 60/1 to 2/1. Results indicated that SRB play an unexpected role in process failure. When systems failed, both sulfate reduction and methane production shut down. Levels of hydrogen sulfide associated with irreversible failure were near 60 mg S/L for both acctate and propionate systems; corresponding total dissolved propionate systems; corresponding total dissolved sulfide levels were 145 mg S/L for acetate systems and nearly 200 mg S/L for propionate systems. For similar loading conditions, propionate systems failed sooner than acetate systems. For the conditions tested, solids retention time had little impact on overall process performance and metal nutrition was not a problem. The maximum tolerable sulfate loading rates were estimated to be 26 and 33.3 mg S/L-d for the propionate and acetate systems, re spectively. (Author's abstract) W91-02537

# DENITRIFICATION BY AN EXPANDED BED BIOFILM REACTOR.

D. V. MacDonald.

D. V. MacDonald. Research Journal of the Water Pollution Control Federation JWFFA5, Vol. 62, No. 6, p 796-802, September/October 1990. 9 fig, 6 tab, 9 ref.

Descriptors: \*Biofilm reactors, \*Denitrification, \*Wastewater reactors, \*Wastewater treatment, Anoxic conditions, California, Methanol, Nitrates, Nitrogen, Rancho California Wastewater Reclamation, Wastewater facilities, Wastewater renovation.

The Rancho California Wastewater Reclamation Plant, which has a design capacity of 23.6 mL/d, is located in Southern California approximately 64 km northeast of the city of San Diego. The effluent from this plant is used for irrigation and groundwater recharge. In order to protect the local groundwater from nitritie contamination, the plant must nitrify and subsequently denitrify the plant's effluent to a nitrate-N concentration of 2.5 mg/L. The influent nitrate-N concentration to the denitrication facility is normally in the range of 15 to 20 fication facility is normally in the range of 15 to 20 mg/L. Denitrification is achieved with an upflow mg/L. Denitrification is achieved with an upflow expanded bed biofilm reactor. The reactor is de-signed for a loading of 3.0 kg of nitrate-N/day/cu m of expanded bed volume. The upflow velocity is 0.4 cm/s and the reactor has an empty bed contact time of 10 minutes at design flow. Each reactor has a design capacity of 7.5 mL/d. The biofilm is grown on a medium of sand with an effective size of 0.6 mm and a uniformity coefficient of 1.2. The reactor has a perforated concrete underdrain, 0.6 meters of support gravel, and 1.2 m of sand. Folmeters of support gravel, and 1.2 m of sand. Poli-lowing a two-month startup period, the facility consistently removed 95 to 100% of the nitrate-N. Several requirements were identified from the first year of operation: (1) an effective method of meas-uring and controlling biofilm growth; (2) a reliable methanol feed system; and (3) if very low concen-trations of nitrate-N must be produced, then con-

sideration should be given to scrubbing the off gases and eliminating the potential for odors. It was concluded that the fixed-film expanded bed denitrification system is a cost-effective method of reducing nitrate-N. (MacKeen-PTT)

BATCH BIODEGRADATION OF INDUSTRIAL ORGANIC COMPOUNDS USING MIXED LIQUOR FROM DIFFERENT POTWS.

New Jersey Inst. of Tech., Newark. Dept. of Chemical Engineering. G. A. Lewandowski.

Research Journal of the Water Pollution Control Federation JWPFA5, Vol. 62, No. 6, p 803-809, September/October 1990. 7 fig, 4 tab, 47 ref.

Descriptors: \*Activated sludge, \*Biodegradation, \*Biological wastewater treatment, \*Organic compounds, \*Waste treatment, \*Wastewater treatment, Biological treatment, Chlorinated hydrocarbons, Kinetics, Microbial degradation, Mixed liquor solids, Publicly owned treatment works.

The biological treatment of organic compounds with mixed liquor from different publicly owned treatment works (POTWs) was studied. Experiments conducted using several 5-L batch reactors involved the degradation of single compounds and ments conducted using several 3-L batch reactors involved the degradation of single compounds and mixtures of compounds with two different mixed liquors. One mixed liquor came from a municipal treatment plant with a throughput of 9.5 ML/d of domestic waste; the other came from a plant that treats 95 ML/d of waste that is 55% industrial on a biological oxygen demand basis, including about 227 kg/d of phenol. Microorganisms from the domestic treatment plant degraded chlorinated hydrocarbons (2-chlorophenol, 2,6-dichlorophenol, and 2,4-D) at rates that were virtually the same as those for the plant handling industrial waste. The phenol degradation rates were the same, even though one plant had experienced significant prior exposure. The dominant microbial populations were also similar, both before and after phenolic exposure. Microbial adaptation to the compounds was quite rapid, resulting in a two-fold to five-fold increase in the average degradation rates after only the second exposure in a batch reactor. When multiple substrates were tested, the individual commultiple substrates were tested, the individual com-pound degradation rates in the mixture were very pound degradation rates in the mixture were very similar to the degradation rates as sole carbon source. The amount of throughput and the magni-tude of degradation rates indicate the potential of the plant handling industrial waste to treat signifi-cant quantities of the compounds tested. (Author's abstract) W91-02540

# OPERATIONAL WATER QUALITY MANAGEMENT: CONTROL OF STORM SEWAGE AT A WASTEWATER TREATMENT PLANT.

P. Lessard, and M. B. Beck.
Research Journal of the Water Pollution Control
Federation JWPFA5, Vol. 62, No. 6, p 810-819,
September/October 1990. 9 fig. 10 tab, 36 ref.

Descriptors: \*Storm wastewater, \*Wastewater fa-cilities, \*Wastewater management, \*Wastewater treatment, Control systems, Model studies, Storm water management, Storm-overflow sewers, Water quality control.

In almost all wastewater treatment plants it is customary to control the effects of a surge of stormwater by bypassing flows above a certain threshold directly to the receiving waters. This threshold is normally set at three times the dry-weather flow (3DWF) of wastewater, and in the U.K., is usually accompanied by the installation of storm tanks between the overflow and receiving water. A dynamic model of treatment plant behavior was applied in a comparative study of several alternative strategies of stormwater control. The model comprises the typical unit processes of the liquid train of the plant: storm tanks, primary clarifiers, aeration basins, and secondary clarifiers. The control options include: alternative locations for ners, aeration oasins, and secondary clariners. Ine control options include: alternative locations for the overflow and storm tanks, variations on the theme of the 3DWF concept, alternative modes of operation of the storm tanks, and the manipulation

#### Waste Treatment Processes—Group 5D

of overflow settings during the event. The results of overflow settings during the event. Ine results indicate the virtue of allowing for flexibility in plant designs, especially with respect to: incorporating more than one overflow location, the need for different strategies for different events and of different stategies for different events and different categories of pollutants, and the potential for the beneficial use of real-time forecasting and control of events of low intensity and long duration. (Author's abstract)
W91-02541

FAST DETERMINATION OF THE BIODEGRA-BILITY OF ORGANIC COMPOUNDS IN A LABORATORY-TRICKLING-FILTER (RASCHE BESTIMMUNG DES BIOABBAUS ORGAN-ISCHER STOFFE IN EINEM LABOR-TROPF-

Eidgenoessische Materialpruefungs- und Versuch-sanstalt fuer Industrie, Bauwesen und Gewerbe, St.

Sansan tuer Industrie, bauwesen und Geweroe, St. Gall (Switzerland).

U. Baumann, G. Kuhn, and W. Schefer.
Zeitschrift fuer Wasser - und Abwasser Forschung
ZWABAQ, Vol. 23, No. 4, p 129-132, August
1990. 7 fig, 1 tab, 2 ref. English summary.

Descriptors: \*Analytical methods, \*Biodegrada-tion, \*Organic compounds, \*Trickling filters, \*Wastewater treatment, Bacteria, Carbon dioxide, Dissolved organic carbon, Kinetics, Laboratory methods, Nitrification, Toxicity.

A simple continuous test procedure which allows for the rapid determination of the biological elimination of organic compounds is described. The substances to be tested for biodegrability are dissolved in water, and the solution is continuously fed into a laboratory trickling filter, while measuring the dissolved organic carbon (DOC) remaining in the eluate and the carbon dioxide formation. Based on the kinetics of the DOC concentration in the eluate and the kinetics of carbon dioxide formation, information is obtained about biodegrability, elimination, toxicity to bacteria and adaptation. Nitrification inhibitors are also easily identified. This procedure is also suitable for the rapid extraction of refractory substances from sewage. (Author's abstract) W91-02544

MONITORING PROGRAM ASSESSES WATER QUALITY PROGRESS. Milwaukee Metropolitan Sewerage District, WI. C. Magruder.

Water Environment & Technology WAETEJ, Vol. 2, No. 10, p 8-9, October 1990.

Descriptors: \*Data collections, \*Monitoring, \*Municipal water, "Water districts, "Water pollution control, "Water pollution prevention, "Water quality management, Baseline studies, Data interpretation, Milwaukee, Planning, Stream pollution, Water quality control.

In recent years, Milwaukee's water quality has generated much interest. Area residents are awaiting the completion of the Milwaukee Metropolitan Sewerage District's (MMSD) 2.25 billion Water Pollution Abatement Program (WPAP), and city leaders hope to make a revitalized Milwaukee River the focal point of downtown redevelopment. As the primary agency charged with protecting local water resources, the MMSD has a responsilocal water resources, the MMSD has a responsibility to track water quality. The district's surface water quality monitoring program provides more than a decade of baseline data. At its inception in 1979, the monitoring program covered eight sampling locations on the metro area's three rivers and eleven sampling locations from Milwaukee's Outer Harbor to Lake Michigan. Today the program encompasses six major survey types and 64 sampling locations. The district's monitoring program addresses two major areas: the impact of effluent from the district's two wastewater treatment plants addresses two major areas: the impact of effluent from the district's two wastewater treatment plants and the overall water quality within the district. Most of the sites are visited every other week, and with the aid of computers, MMSD technicians can match the water quality conditions of specific hours and days against data collected up to a decade earlier. Water quality testing parameters fall into four broad categories: conventional testing; biomonitoring by exposing daphnia magna,

Ceriodaphnia dubia and fathead minnows; tracking Ceriodaphnia dubia and fathead minnows; tracking of conservative tracers (i.e., chloride, specific conductance, total alkalinity, and hardness); and heavy metals testing monitoring the 13 EPA priority pollutant metals. In recent years, other public agencies have used the data extensively as a basis for planning. By providing such long-term, comprehensive information to a wide array of users, the monitoring program has helped promote the wise use of limited resources to improve water quality. (VerNooy-PTT) W91-02561

NORTH CAROLINA PLANT SOLVES TEX-TILE-WASTEWATER PROBLEMS.
East Burlington Wastewater Treatment Plant, NC.
A. R. Kornegay, and C. Sell.
Water Environment & Technology WAETEJ,
Vol. 2, No. 10, n.26 Cutober 1999. Vol. 2, No. 10, p 26, October 1990.

Descriptors: \*Dyes, \*Industrial wastewater, \*Tex-tile mill wastes, \*Wastewater facilities, \*Wastewater treatment, Activated carbon, Bioas-say, Monitoring, North Carolina, Wastewater com-position, Water pollution prevention, Water qual-ity standards.

Ity standards.

The East Burlington (NC) wastewater treatment plant is a 12 mgd facility that was upgraded 11 years ago to deal with textile-manufacturing wastewaters that comprised up to 60% of the flow. However, as recently as 6 years ago, the plant's effluent averaged 23 mg/L biological oxygen demand (BOD), 86 mg/L total suspended solids (TSS), and 7.1 mg/L ammonia nitrogen (NH3-N). All three parameters violated East Burlington's summer discharge permit. The plant was upgraded to deal with the problem of old textile plants in the area discharging highly colored effluent, by installation of a PACT system and wet-air regeneration unit. The PACT system follows treatment in an aerated equalization basin and primary treatment, and involves the addition of powdered activated carbon to the aeration chambers of the activated-sludge system. In effect, physical and biological treatment take place simultaneously, successfully removing color, biodegradeables, and non-biodegradeables. Several changes in equipment and operational practices relating to solids control have improved performance. Improvements have greatly reduced from building on the final clarifiers and improved performance. Improvements have greatly reduced foam buildup on the final clarifiers, and the use of skimmers on the secondary clarifiers protects the final filters and has helped lower effluprotects the final filters and has helped lower effluent suspended solids. Before the upgrade, the river was a dark black color. Now, discharge from the plant is crystal clear and the river quality is much improved. Biomonitoring of the effluent with Daphnia is now required, and the plant is passing these new toxicity tests without any problems. (VerNooy-PTT)
W91-02562

ENERGY-EFFICIENT MUNICIPAL SLUDGE

INCINERATION.
Camp, Dresser and McKee, Inc., Cambridge, MA.
For primary bibliographic entry see Field 5E.
W91-02563

FLUID BEHAVIOR/WASTE MANAGEMENT IN LOW-GRAVITY ENVIRONMENTS. Air Force Academy, CO. Dept. of Civil Engineer-

ing.
A. M. Wachinski, and K. T. Preston.
Water Environment & Technology WAETEJ,
Vol. 2, No. 10, p 56-58, October 1990. 2 fig.

Descriptors: \*Fluid mechanics, \*Gravity studies, \*Satellite technology, \*Wastewater management, \*Wastewater renovation, \*Wastewater treatment, Buoyancy, Convection, Design criteria, Microgravity, Sedimentation, Systems engineering, Waste management.

Current plans for the US space station are to current pians for the Us space station are to recycle as much wastewater as possible to reduce shuttle resupply requirements. However, fluid be-havior in space differs markedly from that in a gravity-dominated environment. The term zero-G strictly means a total absence of gravity where the net contact force on the system under consider-

ation is zero. Aboard an orbiting spacecraft objects behave as they would in a very weak gravitational field (in microgravity), and space engineers must account for the effects. Basic phenomena such as near (in microgravity), and space engineers must account for the effects. Basic phenomena such as buoyancy, settling, convection, mixing and diffusion are considerably different in a microgravity environment. Multi-phase water systems, such as water and air or water and suspended solids, will pose special design considerations in a microgravity environment. In low gravity or microgravity, body forces approach zero, consequently hydrostatic pressure, buoyancy, convection, and sedimentation approach zero. A discussion is presented of these forces. The characteristics of microgravity fluid behavior that affect waste management stem from one fact—there is an absence of body forces. Sedimentation and flotation are eliminated, while surface tension and capillarity play the major role in fluid behavior. The changes are significant for all fluid processes, but they are extremely critical in spacecraft environmental design. (VerNooy-PTT) W91-02565

USING PROGRAMMABLE LOGIC CONTROL-

Central Contra Costa County Sanitary District, Martinez, CA.

Water Environment & Technology WAETEJ, Vol. 2, No. 10, p 64-67, October 1990. 8 fig.

Descriptors: \*Automation, \*Control systems, \*Electronic equipment, \*Process control, \*Programmable logic controllers, \*Wastewater facilities, California, Computer programs, Monitoring, Project planning, Secondary wastewater treatment, Sludge drying.

Programmable logic controllers (PLCs) are a good Programmable logic controllers (PLCs) are a good choice for equipment and process control in wastewater treatment plants. Central Contra Costa Sanitary District in Martinez, CA, operates a 45-mgd secondary treatment plant designed during the late 1960s. In 1986, the district constructed a new furnace-control room and, in doing so, replaced all of the relays in the existing control panels with a small PLC. For the furnace-control room, a PLC was chosen as a relay replacement; however, the PLC was also used instead of extending all of the wires from the existing control panels to the new furnace-control room. Next the district specified a PLC system for its dewatering system to control new sludge-dewatering centrifuges and to the new furnace-control room. Next the district specified a PLC system for its dewatering system to control new sludge-dewatering centrifuges and associated equipment. With PLCs controlling the centrifuges, the district began using PLCs for PID control, to adjust the differential speed of the centrifuge's scroll conveyor. This control maintains a consistent sludge-cake density. One of the main advantages in a PLC system is the ease with which the system can be modified. Another advantage is the ease of PLCs in troubleshooting. With the programming device connected to the PLC, the ladder logic can be viewed on a screen showing the current flow instead of measuring voltages. Discussion is made of the process of getting from the planning stage of a PLC system to a working system, including specifications, testing, and operation, many new uses have been found. Sludge-incinerator hearth-burner status was brought in to the central computer so it could be monitored and status signals for equipment were sent to the alarm panel in the furnace-control room. The district has also evaluated the interface to see if it could replace the existing telemetry system. (VerNooy-PTT) W91-02566

BIODEGRADATION OF TOXIC ORGANICS: STATUS AND POTENTIAL.

Clemson Univ., SC. Dept. of Environmental Systems Engineering.

C. P. L. Grady.

Journal of Environmental Engineering (ASCE)
JOEEDU, Vol. 116, No. 5, p 805-828, 1990. 1 fig, 2 tab, 82 ref.

Descriptors: \*Biodegradation, \*Biological treatment, \*Organic compounds, \*Wastewater treat-

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ment, Biotechnology, Decision making, Literature review, Mathematical models, Microbiological studies, Waste management, Waste treatment.

The ability of biological treatment systems to degrade toxic organic compounds is assessed through a review of the literature. While much general information is available, there is little kinetic inforinformation is available, there is little kinetic infor-mation that can be used directly by engineers making decisions about process alternatives. Nev-ertheless, useful kinetic information can be ob-tained from biodegradation studies in which the toxic compound of interest serves as the sole sub-strate for microbial growth. A scheme is proposed whereby such information can be used in mathewhereby such information can be used in mathematical models to predict the extent to which the toxic compounds can be removed from complex waste streams. A methodology is proposed whereby the impacts of the toxic compounds on the biodegradation of the biogenic organic material in the waste streams can be predicted. New information about environmental biotechnology is being generated by biologists faster than engineers can assimilate and apply it. Thus, close alliances must be formed between engineers and scientists to fully exploit the potential offered by biotechnology. (Author's abstract) W91-02568

SIMPLE SOLUTIONS FOR STEADY-STATE

BIOFILM REACTORS.
Clemson Univ., SC. Dept. of Environmental Sys-P. S. Golla, and T. J. Overcamp.
Journal of Environmental Engineering (ASCE)
JOEEDU, Vol. 116, No. 5, p 829-836, 1990. 1 fig, 9

Descriptors: \*Biofilm reactors, \*Biological reactors, \*Model studies, \*Wastewater reactors, \*Wastewater treatment, Biofilms, Biological treatment, Biological wastewater treatment, Limiting factors, Substrates.

Simple analytical models for use in preliminary Simple analytical models for use in preiminary calculations are developed to approximate the steady-state concentration and biofilm thickness in a biofilm reactor. The models presented considered the case in which a single substrate limits growth. These models assume that the flux of substrate to These models assume that the flux of substance to the biofilm has a first order dependence on the bulk substrate concentration. This assumption restricts the use of the models to low initial substrate concentrations. One of the models assumes plug flow, and the other incorporates longitudinal dis-persion of substrate. The models allow the substrate concentration to approach the minimum rate limiting concentration and the biofilm thickness to approach zero as predicted by the steady-state theory. Predictions of these models are compared to those of a steady-state numerical model. For an to those of a steady-state numerical model. For an example taken from the literature, the solution of the model with longitudinal dispersion is in good agreement with the numerical solution. (Author's abstract)
W91-02569

FREEZING OF WATER AND WASTEWATER SLUDGES.

Duke Univ., Durham, NC. Dept. of Civil and

P. A. Vesilind, and C. J. Martel.

Journal of Environmental Engineering (ASCE)

JOEEDU, Vol. 116, No. 5, p 854-862, 1990. 5 fig,

Descriptors: \*Freezing, \*Sludge drying, \*Wastewater management, \*Wastewater treatment, Crystallization, Freeze-thaw tests, Physical treatment, Sludge, Sludge treatment, Temperature.

When sludge is allowed to freeze slowly and then thaw, its dewatering properties are usually greatly improved. The mechanisms by which this improvement occurs are not well understood. Therefore, the authors have proposed a conceptual model for how sludge freezes. The effectiveness of freeze/thaw is measured using the capillary suction apparatus with the results indicating that colder temperatures, longer freezing times and slower freezing rates all have a beneficial effect. These

results suggest that if freeze/thaw is to be used commercially, thin layers of sludge must be frozen for long periods of time, thereby promoting the growth of crystals that will exclude the solid particles and promote particle aggregation. (Author's abstract) abstract) W91-02571

CONTINUOUS PRE-ANOXIC AND AEROBIC DIGESTION OF WASTE ACTIVATED

Maryland Univ., College Park. Dept. of Civil En-

O. J. Hao, and M. H. Kim.

Journal of Environmental Engineering (ASCE)
JOEEDU, Vol. 116, No. 5, p 863-879, 1990. 11 fig,
5 tab, 19 ref, append.

Descriptors: \*Activated sludge process, \*Aerobic digestion, \*Sludge digestion, \*Sludge stabilization, \*Wastewater treatment, Biomass, Denitrification, Nitrates, Nitrification, Suspended solids, Volatile

Conventional aerobic sludge stabilization requires extensive energy input. Incorporation of endoge-nous nitrate respiration (ENR) into the aerobicdigestion system offers an energy saving advan-tage. In the ENR system, nitrate instead of oxygen is utilized for biomass destruction. Continuous pre-anoxic and aerobic digestion of waste activated sludge was studied to evaluate its effectiveness for sludge was studied to evaluate its effectiveness for volatile suspended solids (VSS) destruction and nitrogen removal. The ENR occurs in the anoxic digester because of the recycling of nitrate from the aerobic digester. The anoxic effluent, in turn, provides a high pH and adequate buffer capacity for enhancing the subsequent aerobic decay and nitrification. Two experimental runs, differing in intrincation. Two experimental runs, offering in hydraulic detention time in anoxic and aerobic tanks, are conducted with the same recycling rate. The results indicate that total nitrogen removal is approximately 25%, with 40% VSS destruction. The denitrification/nitrification efficiencies and rates were also determined. A mathematical model developed from the mass balance of biomass, amonium, and nitrate can reasonably predict the transient responses of these parameters. (Author's abstract) W91-02572

TESTING EXPERT SYSTEM FOR ACTIVATED SLUDGE PROCESS CONTROL.

SLUDGE PROCESS CONTROL.
A.T. and T. Bell Labs, Naperville, IL.
W. Lai, and P. M. Berthouex.
Journal of Environmental Engineering (ASCE)
JOEEDU, Vol. 116, No. 5, p 890-909, 1990. 6 tab,
44 ref. EPA Agreement No. CR-812655-01-0.

Descriptors: \*Activated sludge process, \*Computer programs, \*Expert systems, \*Process control, \*Wastewater treatment, Data interpretation, Information management, Sludge digestion, Wastewater

The wastewater treatment plant operator's most difficult problem is collecting, storing, manipulating and interpreting data; an information management problem. The operator's performance in controlling the treatment process can be improved if he is equipped with a convenient and efficient method for extracting useful information from the data. A rule-based expert system within an integrated information management system is presented in this article. The expert system only considers the activated sludge process, but the information system is for the entire treatment plant. The expert system provides the operator with timely advice based on the latest available process data as inter-preted by a set of rules constructed with the help of experienced and skilled operators. Case studies are presented to help develop an approach for refining the control rules as well as testing their accuracy and effectiveness. The expert system consistently reproduced the expert operators decisions and performed better than nonexpert operators. (Lantz-PTT) W91-02573

BOUNDED IMPLICIT ENUMERATION FOR WASTEWATER-TREATMENT SYSTEMS.

North Carolina Agricultural and Technical State Univ., Greensboro. Dept. of Civil Engineering. S. Y. Chang, and S. L. Liaw. Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 5, p 910-926, 1990. 6 fig, 5

Descriptors: \*Mathematical models, \*Model stud-ies, \*Systems engineering, \*Wastewater treatment, Computer programs, Cost-benefit analysis, Mathe-matical studies.

A wastewater treatment system can be represented by a multistage configuration consisting of a varie-ty of unit processes from various stages. The number of treatment combinations may be very number of treatment combinations may be very large when the number of unit processes in a stage and the number of stages in a system increase. Enumeration techniques, e.g., total enumeration and implicit enumeration, have been used to eliminate infeasible treatment combinations and to identify the least cost treatment system. A bounded implicit enumeration approach is proposed to make the implicit enumeration more efficient. A lower bound is calculated at each stage and added to the up-to-date objective function value to eliminate more combinations before reaching the final stage. The results for two wastewater treatment system The results for two wastewater treatment system synthesis models indicate that the bounded implicit synthesis modes that the bounded implicit enumeration is consistently more efficient than the total and implicit enumeration approaches in iden-tifying least cost and feasible treatment alterna-tives. (Author's abstract) W91-02574

NEW APPROACH FOR OPTIMIZATION OF URBAN DRAINAGE SYSTEMS.

URBAN DRAINAGE SYSTEMS.
Bradford Univ. (England). Dept. of Civil Enginering and Structural Engineering.
G. Li, and R. G. S. Matthew.
Journal of Environmental Engineering (ASCE)
JOEEDU, Vol. 116, No. 5, p 927-944, 1990. 4 fig, 5 tab, 16 ref, append.

Descriptors: \*Drainage systems, \*Optimization, \*Urban drainage, \*Urban runoff, Construction, Costs, Design standards, Flow rates, Pipes, Pumping plants, Surface runoff.

ang plants, Surface runoff.

A new approach for the optimization of urban drainage systems, including the optimal selection of layout using the searching direction method and the optimal design of a given layout by discrete differential dynamic programming (DDDP), were developed and applied to a typical field study. It was found that the inclusion of such hydraulic factors as flow rate, the sizes and gradients of pipes, and the effect of on-line pumping stations into consideration, is very important in urban drainage systems layout selection. Also, the optimization of urban drainage systems, including optimal layout selection, can achieve much greater construction cost savings than that without the inclusion of layout optimization. It was also demonstrated that the minimum buried depth design is not the global optimum design. Rather, the global optimum design is the alternative of the optimal balance among the buried depth, and the number and locations of on-line pumping stations. (Author's abstract) W91-02575

CHARACTERIZATION OF ACTIVATED SLUDGE FOAMS FROM TWO PLANTS.

Blue Plains Wastewater Treatment Plant, Washington, DC.

Ington, D.C., G. T. Fahmy, and O. J. Hao. Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 5, p 991-997, 1990. 2 fig, 2

Descriptors: \*Activated sludge process, \*Foaming, \*Wastewater treatment, Adenosine triphosphate, Biomass, Carbohydrates, Nitrogen, Sludge digestion, Volatile solids.

Activated sludge (AS) foaming problems have re-cently received considerable attention. Excessive foaming not only causes deterioration in effluent quality, but also presents operational and mainte-

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nance problems, and possible health hazards. The occurrence of sludge foaming has been associated with different and often conflicting operational and environmental factors. The objective of this study was to characterize activated sludge foams in terms of volatile content, lipid, nitrogen and carbo-hydrate composition, adenosine triphosphate (ATP) level, hydrolysis characteristics, and sub-strate utilization. Excessive foams must be re-moved promptly, otherwise the recycle of foams will lead to more severe scum production. Conse-quently the results of foam hydrolysis and its treat-ability may provide an alternative for ultimate terms of volatile content, lipid, nitrogen and carboquently the results of foam hydrolysis and its freat-ability may provide an alternative for ultimate foam disposal. For the purpose of comparison, mixed liquor (ML) was also used for these parame-ter measurements. The results indicate that foam may contain a significant amount of substrate and may contain a significant amount of substrate and lipid. The foam contents vary from plant to plant and even within the same plant. The microbial activity of AS foam was found to be similar to that of ML. These factors provide a perfect environment and abundant substrate for foam causing bactical that the processing bactical that the teria that can degrade many of the organic com-pounds previously accumulated at the air-water pounds previously accumulated at the air-water interface. The net result is that an active biomass population exists at the surface of the aeration basin that has a significant impact on the system ecology and hence substrate removal. In addition, this foam biomass should be included in the biomass inventory used to calculate the solids retention time. The disposal of AS foams presents additional operational and maintenance problems. Hydrolysis of foam using low pH plus heat treatmet seems to be a viable alternative for foam disposal. This eliminates the problem of transferring foam seems to be a viable alternative for foam disposal. This eliminates the problem of transferring foam causing organisms to the anaerobic digester. Hydrolyzed foam can be effectively treated in a activated sludge plant with little impact on the COD-removal efficiency. (Lantz-PTT)

CONTINUOUS ANAEROBIC TREATMENT OF PULPING WASTEWATERS. Agricultural Univ., Wageningen (Netherlands). Dept. of Environmental Technology. R. Sierra-Alverez, J. Harbrecht, S. Kortekaas, and G. Lettinge.

Journal of Fermentation and Bioengineering JFBIEX, Vol. 70, No. 2, p 119-127, 1990. 9 fig. 5

Descriptors: \*Anaerobic digestion, \*Industrial wastewater, \*Pulp wastes, \*Wastewater treatment, Biological treatment, Biological wastewater treatment, Chemical oxygen demand, Lignin, Organic compounds, Thermal wastes.

erobic treatability of thermochemical pulping (TMP) effluents and soda pulping liquors was evaluated in this study. Continuous experiments ing (1MF) efficients and socia pulping inquors was evaluated in this study. Continuous experiments were conducted in laboratory scale upflow anaerobic sludge bed (UASB) reactors innoculated with anaerobic granular sludge at 30 C +/-2 C. TMP wastewaters were found to be highly suitable for anaerobic treatment. The application of high organic loadings (31 g COD/L/d) was feasible by the end of the continuous experiment with TMP wastewaters, with 68 and 98%, total COD and biodegradable COD elimination efficiencies, respectively. Unlike TMP effluents, soda pulping wastewaters were highly inhibitory to methanogenic bacteria and they contained important fractions of recalcitrant organic matter. Wood resin constituents were shown to be responsible for most of the methanogenic inhibition in these wastewaters. None-the-less, anaerobic wastewater treatment was found to be feasible for the removal of biodegradable substrates in soda pumping treatment was found to be feasible for the removal of biodegradable substrates in soda pumping wastewaters if the wastewaters are diluted to subtoxic levels or detoxified by pretreatment with absorbent Amberlite XAD-2 prior to biological treatment. Low COD removal efficiencies were observed during the continuous experiment (45 to 50%) with soda pulping liquors, due to the high amounts of recalcitrant lignin in these wastewaters. The elimination of UV280 absorbance (15-20%) indicated the partial removal of some lignin components by anaerobic treatment. The lignin fraction removed or biotransferred anaerobically corresponded to low molecular weight lignin derivaresponded to low molecular weight lignin deriva-tives as confirmed by gel chromatography results. (Author's abstract)

W91-02580

INVESTIGATION OF REST AREA REQUIRE-MENTS: APPENDIX-PERTINENT REST AREA LITERATURE.

Texas Univ. at Austin. Center for Transportation

Research.
W. T. Straughan, D. W. Fowler, and K. W. Perry.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB89-194807.
Price codes: A03 in paper copy, A01 in microfiche.
Research Report 442-1, Volume 2, November
1987. 62 p, 66 ref, append. Texas State Department
of Highways and Public Transportation Project 318-86-442.

Descriptors: \*Data acquisition, \*Highways, \*Literature review, \*Municipal water, \*Surveys, \*Wastewater management, Design standards, Site selection, Water supply.

Rest areas are an important part of highway systems, particularly on the interstate systems. Based on the findings presented in previous reports, rectems, particularly on the interstate systems. Based on the findings presented in previous reports, recommended design procedures are presented. Recommendations include: spacing, site requirements, example architectural designs, materials, mechanical systems, and operation and maintenance. Recommendations for energy sources, water systems, and wastewater systems are also made. The appendix contains detailed information on surveys and interviews. (Lantz-PTT) W91-02620

WETLAND AREAS: NATURAL WATER TREATMENT SYSTEM (JAN 78 - AUG 89). CITATIONS FROM THE POLLUTION ABSTRACTS DATABASE.

DAVIS (J.) Associates, Inc., McLean, VA. Available from the National Technical Information Service, Springfield, VA 22161, as PB90-862244. Price codes: NOI in paper copy, NOI in microfiche. March 1990. 99p.

Descriptors: \*Artificial wetlands, \*Bibliographies, \*Environmental effects, \*Environmental protection, \*Path of pollutants, \*Wastewater treatment, \*Wetlands, Agricultural runoff, Flooding, Habitats, Water pollution effects.

This bibliography contains citations concerning the ability of salt marshes, tidal flats, marshlands, bogs, and other wetland areas to degrade, absorb, filter, and other wetland areas to degrade, absorb, filter, consume, mitigate natural and man-made pollution and wastes, while maintaining their ability to provide refuge and breeding grounds for wildlife. The ecology, biochemistry, and viability of naturally occurring and artificially established wetlands as water-treatment systems and wildlife areas are considered. The effects of individual pollutants, environmental factors, species diversity, and cleansing ability of wetland areas on the potential for wildlife refuge, sewage treatment, treatment of industriability of wetland areas on the potential for wild-life refuge, sewage treatment, treatment of industri-al and municipal wastes, handling agricultural runoff, mitigating accidental spills, and flooding are discussed. This updated bibliography contains 243 citations, 21 of which are new entries to the previous edition. (Author's abstract) W91-02642

WASTEWATER TREATMENT: CHEMICAL IN-DUSTRY (JAN 70 - SEP 89), CITATIONS FROM THE POLLUTION ABSTRACTS DATABASE.

Davis (J.), Associates, Inc., McLean, VA.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB89-871057.
Price codes: NOI in paper copy, NOI in microfiche.
September 1989. 79p.

Descriptors: \*Bibliographies, \*Chemical wastes, \*Industrial wastewater, \*Wastewater treatment, Activated carbon, Biological treatment, Fertilizers, Mercury, Pesticides.

This bibliography contains citations concerning wastewater treatment in the chemical industry rel-ative to a wide variety of industrial pollutants. Biological treatments including carbon additives are described relative to effectiveness. The removal of mercury and its compounds are included, as

well as associated problems and recommendations from fertilizer and pesticide pollution. This updat-ed bibliography contains 250 citations, 16 of which are new entries to the previous edition. (Author's W91-02644

PULPING EFFLUENTS; BIOLOGICAL TREAT-MENT (JAN 76 - SEP 89), CITATIONS FROM THE PAPER & BOARD, PRINTING & PACK-AGING INDUSTRIES RESEARCH ASSOCIA-

Davis (J.J.) Associates, Inc., McLean, VA. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-871248. Price codes: A01 in paper copy, A01 in microfiche. September 1989, 31p.

Descriptors: "Bibliographies, a Biological wastewater treatment, "Pulp and paper industry, Pulp wastes, "Wastewater treatment, Design criteria, Management, Pilot plants, Solid wastes, Tox-

This bibliography contains citations concerning ef-This bibliography contains citations concerning ef-fluent and wastewater biological treatment and disposal in the pulping industry. Effluent toxicity; treatment plant management, treatment systems and equipment design; combined mechanical and biological treatment processes; biological degrada-tion treatment in chemical pulp mills; and the handling and disposal of solid wastes are among the topics discussed. Performance evaluations of biological treatment processes in domestic and forthe topics discussed. Performance evaluations of biological treatment processes in domestic and for-eign plants in full scale operation and pilot pro-grams are considered. This updated bibliography contains 48 citations, 10 of which are new entries to the previous edition. (Author's abstract) W91-02645

REMOVAL AND FATE OF RCRA AND CERCLA TOXIC ORGANIC POLLUTANTS IN WASTEWATER TREATMENT. REMOVAL.

Cincinnati Univ., OH. Dept. of Civil and Environ-

Cincinnati Univ., OH. Dept. of Civil and Environmental Engineering.
S. J. Bhattacharya, R. V. R. Angara, D. F. Bishop, R. A. Dobbs, and B. M. Austern.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-195200/AS. Price codes: AO8 in paper copy, AO1 in microfiche. Report No. EPA/600/2-89/026. June 1989. 159p, 1 fig, 14 tab, appends.

Descriptors: \*Activated sludge process, \*Organic pollutants, \*Testing procedures, \*Toxic wastes, \*Wastewater treatment, Aliphatic solvents, Benzene, Biodegradation, Chemical oxygen demand, Suspended solids.

Two separate studies were conducted to investigate the removal and fate of 28 selected Resource Conservation and Recovery Act (RCRA) compounds (0.25 mg/L of each compound) and 19 selected CERCLA compounds (0.5 mg/L of each compound) in conventional activated sludge treatment. In each study, two pilot-scale (35 gpm) activated sludge systems (sludge retention time: 4 days for RCRA study and 8 days for CERCLA study) were operated in parallel at the U.S. EPA Test and Evaluation Facility in Cincinnati, Ohio. One system was soiked continuously with either Test and Evaluation Facility in Cincinnati, Ohio. One system was spiked continuously with either RCRA or CERCLA toxics to produce an acclimated biomass; the other was spiked intermittently with the same toxics and sampled to determine performance under unacclimated conditions. The selected RCRA or CERCLA compounds did not cause any adverse effects on chemical oxygen demand (COD) and suspended solids (SS) removal. demand (CCD) and suspended solids (SS) removal.

The concentrations of organics (RCRA study) in air emissions indicated that the chlorinated aliphatic solvents were essentially volatilized into the plant air emission stream, whereas the aromatic volatile benzenes were substantially degraded. Pesvolutile belizens were substantially degrated. Per ticides and phthalates are removed by both sorption on sludges and by biodegradation. These air emission results qualitatively confirm results from earlier bench scale studies which had superior analytical reliability but without the real world sam-pling and wastewater matrix effects. (Author's ab-

#### **Group 5D—Waste Treatment Processes**

W91-02653

WASTEWATER TREATMENT: OZONATION PROCESSES AND EQUIPMENT (JAN 77-APR 90). CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATA-

National Technical Information Service, Spring-

National Technical Information Service, Springfield, VA.

Available from the National Technical Information Service, Springfield, VA 22161, as PB90-864422.

Price codes: NO1 in paper copy, AO1 in microfiche. Report No. NZ9955. April 1990. 160p.

Descriptors: \*Bibliographies, \*Disinfection, \*Qzonation, \*Wastewater treatment, \*Water treat-ment, Chlorination, Comparison studies, Inorganic wastes, Organic wastes, Reaction kinetics.

This bibliography contains citations concerning the use of ozonation processes for wastewater disinfec-tion. Topics include system descriptions and evalnon. Topics include system descriptions and evaluation, comparisons with the chlorination process, reaction kinetics, and the use of the process in combination with other wastewater treatment methods. The treatment of organic and inorganic compounds in wastewater and municipal water supplies is discussed. (This updated bibliography contains 318 citations, 26 of which are new entries to the previous edition.) (Author's abstract)
W91-02667

WASTE WATER, INFILTRATION-PERCOLA-TION FOR AQUIFER RECHARGE OR WATER RE-USE

Montpellier-2 Univ. (France). Lab. d'Hydrologie et de Modelisation. F. Brissaud, F. Lefevre, C. Joseph, Z. Alamy, and

A. Landreau. IN: Ground A. Landreau.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 443-455, 4 fig, 14 ref.

Descriptors: \*Aquifer management, \*Groundwater management, \*Groundwater resources, \*Wastewater renovation, \*Wastewater treatment, \*Water resources management, \*Water reuse, Effluents, France, Groundwater recharge, Irrigation water, Percolating filters, Percolating water, Pollution load, Self-purification, Water storage.

Renovated wastewater may be stored for reuse as irrigation water during the dry season. Infiltration-percolation is a rustic and extensive purifying techpercolation is a rustic and extensive purifying technique which is capable of completely oxidizing and decontaminating wastewater. It is particularly adapted to wastewater reutilization projects and to the recharge of shallow groundwater planned to be used for the interseasonal storage of purified water. The wastewater is purified during its percolation through unsaturated sandy media. An exemplary model of the convective renewal of oxygen in the gaseous phase supplies the basis of the designs and, for only slightly-loaded or medium-loaded wastewater, of the dimensions of the infiltration-percolation plants. An experiment confirmed that this technique is capable of purifying heavily-loaded effluents (primary effluents with an oxygen demand of more than 250 mg/L) on the condition that hollow structures are introduced into the filthat hollow structures are introduced into the fil-tering beds. This laboratory work was followed by implementation of this technique into actual oper-ations in France, with the aim of improving knowledge on the subject of basin-supplying systems and of monitoring the evolution of the gaseous oxygen stock in the filtering medium during purification. The various technologies are currently being tested at these stations. (See also W91-02672) (Author's abstract) W91-02710

COMMITMENT TO MONITORING AND SAM-PLING. Lakeland, FL.

T. Lokken.

Water Engineering and Management WENMD2, Vol. 137, No. 9, p 28-31, September 1990. 2 fig, 1

Descriptors: \*Florida, \*Wastewater analysis, \*Wastewater facilities, \*Wastewater management, \*Wastewater treatment, \*Water quality monitoring, \*Water sampling, Economic aspects, Industri-al wastewater. Pretreatment of wastewater. Priority pollutants, Process control, Sludge

wastewater treatment facilities of the City of The wastewater treatment facilities of the City of Lakeland, Florida, are among the most complex in the state, yet they are also recognized as being among the most effective and efficient. One major reason for this efficiency is commitment to thorough monitoring and sampling which exceeds Enterpressed Protection. Agency (EPA) resultances reason for this efficiency is commitment to information and assimpling which exceeds Environmental Protection Agency (EPA) requirements but yields major benefits in treatment quality and cost savings. The key to successful process control at the plants is sampling. Careful monitoring prevents energy waste and allows more efficient use of materials. Monitoring also insures the most effective processing of the wastewater. Nutrients and nitrogen levels which affect biological activity can be examined and adjustments made if necessary. Data gathered through monitoring is used to control the activated sludge system, anaerobic digestion, and sludge thickening, and to control chemical usage. Monitoring is also used to track costs for such programs as odor control. Efficiency of processes is tracked by monitoring the quality of influent and effluent. In addition to in-plant monitoring, the Lakeland wastewater treatment program includes an extensive industrial monitoring program. Pretreatment programs conmonitoring program. Pretreatment programs conducted by area industries are monitored to insure ducted by area industries are monitored to insure that wastewater form the industrial plants meets EPA limits on heavy metals, cyanide and other priority pollutants which could damage the treat-ment plants. (Korn-PTT) W91-02763

DIGESTER GAS IS ALTERNATE FUEL.

San Antonio Dept. of Wastewater Management,

F. Rodriguez.

Water Engineering and Management WENMD2, Vol. 137, No. 9, p 32-33, September 1990. 1 fig.

Descriptors: \*Anaerobic digestion, \*Digester gas, \*Energy recovery, \*Energy sources, \*Fuel, \*Wastewater treatment, Insurance, Process control, San Antonio, Texas,

Dos Rios Wastewater Treatment Plant is an expansion facility that was built to service part of the growing community of San Antonio, Tex. The San Antonio wastewater treatment facilities require two medium-sized hot-water boilers and one small low-pressure steam boiler. Previously, the city was flaring the anaerobic gas supply and losing all energy potential. The city currently uses the heat to maintain a controlled environment in the digester to produce gas and then, fires the boilers with the gas in order to produce heat. The digester gas the gas in order to produce heat. The digester gas system uses a dual canister burner that is designed for separate combustion control for two gases with different fuel characteristics. The dual canister housing arrangement applies specifically to gases with low heating value. The separate burner arrangement-where the two gases do not use the same orifice ring-is critical to proper combustion setting and efficiency. The multi-gas system provides separate fuel-handling systems for each fuel. By using separate fuel trains, fuel consistency is maintained and problems associated with mixing of fuels is avoided. Also, by providing fuel trains that do not share any common piping, automatic nuets is avoided. Also, by providing fuel trains that do not share any common piping, automatic change-over is easily incorporated. Furthermore, separate fuel trains comply with current insurance regulations. (Korn-PTT)
W91-02764

BIODEGRADATION OF P-NITROPHENOL IN AN AQUEOUS WASTE STREAM BY IMMOBI-LIZED BACTERIA.

Monsanto Environmental Sciences Center, St.

M. A. Heitkamp, V. Camel, T. J. Reuter, and W. J.

Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 10, p 2967-2973, October 1990. 5 fig, 26 ref.

Descriptors: \*Activated sludge process, \*Bacteria, \*Biodegradation, \*Nitrophenols, \*Wastewater treatment, Adsorption, Microbial degradation, Path of pollutants, Pseudomonas, Toxicity, Waste

Microbiological analyses of activated sludge reactors after repeated exposure to 100 mg of p-nitro-phenol (PNP) per liter resulted in the isolation of phenol (PNP) per liter resulted in the isolation of three Pseudomonas species able to utilize PNP as a sole source of carbon and energy. Cell suspension of the three Pseudomonas sp., designated PNP1, PNP2, and PNP3, mineralized 70, 60, and 45% of a 70 mg/L dose of PNP in 24, 48, and 96 h. Mass 70 mg/L dose of PNP in 24, 48, and 96. h. Mass balance analyses of PNP residues for all three cultures showed that undegraded PNP was < 1% (<50 microg); volatile metabolites, < 1%; cell residues, 84 to 14.9%; and water soluble metabolites, 1.2 to 6.7%. A mixed culture of all three PNP-degrading Pseudomonas sp. was immobilized by adsorption onto distormaceous earth biocarrier. PNP-degrading Pseudomonas sp. was immobilized by adsorption onto diatomaceous earth biocarrier in a 1.75 L Plexiglas column. The column was aerated and exposed to a synthetic waste stream containing 629 to 2513 mg of PNP per liter at flow rates of 2 to 15 ml/min. Chemical loading studies showed that the threshold concentration for acute toxicity of PNP to the immobilized bacteria was toxicity of PNP to the immobilized bacteria was 2100 to 2500 mg/L. Further studies at PNP concentrations of 1200 to 1800 mg/L showed that > 99, and 91 to 99% removal of PNP was achieved by immobilized bacteria at flow rates of 10 and 12 mL/min. These values represent hydraulic retention times of 48 to 58 min and PNP removal rates of 0.99 to 1.1 mg/h/g of biocarrier at 25 C under optimal conditions. This study shows the successful research of the property of ful use of immobilized bacteria technology to remove high concentrations of PNP from aqueous waste streams. (Author's abstract) W91-02768

DEGRADATION OF VINYL ACETATE BY SOIL, SEWAGE, SLUDGE, AND THE NEWLY ISOLATED AEROBIC BACTERIUM V2. Bayreuth Univ. (Germany, F.R.). Lehrstuhl fuer

Mikrobiologie.
M. Nieder, B. Sunarko, and O. Meyer. Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 10, p 3023-3028, October 1990. 4 fig, 3 tab, 25 ref. Bundesministerium fur Forschung und Technologie Grant No. 0318839 B.

Descriptors: \*Biochemistry, \*Biodegradation, \*Fate of pollutants, \*Path of pollutants, \*Vinyl acetate, \*Wastewater treatment, Bacteria, Chemical reactions, Enzymes, Hydrolysis, Sludge, Soil chemistry, Wastewater.

Vinyl acetate is subject to microbial degradation in the environment and by pure cultures, and can be hydrolyzed by samples of soil, sludge, and sewage at rates of up to 6.38 and 1 mmol/h/g (dry weight) under aerobic and anaerobic conditions. Four yeasts and thirteen bacteria that feed aerobically yeasts and thirteen bacteria that feed aerobically on vinyl acetate were isolated, but in this study, the pathway of vinyl acetate degradation was followed in bacterium V2. Vinyl acetate is first degraded to acetate, which is then converted to acetyl coenzyme A and oxidized through the tricarboxylic acid cycle and the glyoxylate bypass. The key enzyme of the pathway is vinyl acetate esterase, which hydrolyzes the ester to acetate and actival alcohol. The letter increasizes reportaneously. vinyl alcohol. The latter isomerizes spontaneously to acetaldehyde and converts to acetate. The acetaldehyde is then disproportionated into ethanol and acetate. The enzymes involved in the metaboand acetate. The enzymes involved in the metabo-lism of vinyl acetate were studied in extracts. Vinyl acetate esterase (K-m = 6.13 mM) was also active with indoxyl acetate (K-m = 0.98 mM), providing the basis for a convenient spectrophoto-metric test. Substrates of aldehyde dehydrogenase were formaldehyde, acetaldehyde, propionalde-hyde, and butyraldehyde. The enzyme was equally active with NAD+ or NADP+. Alcohol dehy-drogenase was active with ethanol (K-m = 0.16 mM) and was linked to NAD+. The molecular sizes of aldehyde dehydrogenase and alcohol dehysizes of aldehyde dehydrogenase and alcohol dehy-drogenase were 145 and 215 kilodaltons, respectively. (Author's abstract) W91-02769

# Waste Treatment Processes—Group 5D

POSSIBLE IMPORTANCE OF WIND AER-ATION IN CONTROLLING ODOURS FROM PIGGERY SLURRY STORED AFTER AERO-BIC TREATMENT.

BIC TREATMENT: AFRC Inst. of Engineering Research, Silsoe (England). Process Engineering Div. R. W. Sneath, and A. G. Williams. Biological Wastes BIWAED, Vol. 33, No. 3, p 151-159, 1990. 1 fig, 1 tab, 6 ref.

Descriptors: \*Aeration, \*Aerobic treatment, \*Farm wastes, \*Odor control, \*Wastewater treatment, \*Wind, Aerated lagoons, Biochemical oxygen demand, Oxygen, Retention time, Waste storage, Waste treatment.

Several methods of controlling odors from piggery slurry have been used successfully, but aerobic treatment is able not only to render odors inoffensive, but also, if more thorough, to remove them completely. A manometric respirometer was used to measure the long-term biochemical oxygen demand of aerobically treated slurries. Different demand of aerobically treated slurries. Different regimes were used to treat each of two samples of the slurry: a 1-day solids retention time with oxygen supplied to maintain dissolved oxygen at 0.5 mg/L, and a 2-day solids retention time with a lower aeration rate that controlled the redox potential at 181 mV and the dissolved oxygen at 0 mg/L. Readings were taken daily for 80 days and then once weekly for another e5 days. Calculations using data from the experiment estimate the effect that the wind-mediated transfer of oxygen from the atmosphere into the slurry in a storage tank or atmosphere into the slurry in a storage tank or lagoon might have upon the time of the return of an offensive odor. Results show that the effect of wind aeration is potentially far greater than that of even a fourfold increase in the solids residence time of the prior aerobic treatment. Storing aerobically-treated piggery slurry in a lagoon of maximum depth of 2 m could permit wind aeration mum depth of 2 m could permit wind aeration sufficient to increase the period for which the odors would not be offensive from a maximum of 30 days after a 4-day solids retention time treatment to more than 180 days, even when the slurry had had only a 1-day solids retention time treatment. (Brunone-PTT) W91-02772

INHIBITORY EFFECT OF CITRUS UNSHU

PEEL ON ANAEROBIC DIGESTION.
Fukushima Industrial Inst. of Fukuoka Prefecture,

Puxumilia lindusini Yame (Japan). E. Mizuki, T. Akao, and T. Saruwatari. Biological Wastes BIWAED, Vol. 33, No. 3, p 161-168, 1990. 4 fig, 1 tab, 7 ref.

Descriptors: \*Anaerobic digestion, \*Citrus crops, \*Toxicity, \*Wastewater treatment, Biodegradation, Fermentation, Industrial wastes, Methane bacteria. Methanogenesis.

In Japan, Citrus unshu is the most commercially important citrus fruit. A number of Japanese plants produce a large amount of canned and juice products with unshu juice. The citrus wastes from this industry are toxic to the anaerobic digestion of microbes, and create a serious problem for their disposal. A significant inhibition of methane ferdisposal. A significant inhibition of methane fer-mentation was observed in the anaerobic digestion of Citrus unshu peel at loadings above 2 g/L/day. This effect was mainly due to the peel oil, but other substances present in the peel also have an inhibitory effect. The limiting load of peel oil for anaerobic digestion proved to be about 65 microl/ L/day. Citrus unshu peel did not inhibit methane fermentation after the removal of peel oil by steam distillation or aeration. (Author's abstract)

SOME OBSERVATIONS ON ORGANIC RE-MOVAL IN AN SBR.
National Univ. of Singapore. Dept. of Civil Engi-

neering. W. J. Ng, and J. C. Tan. Biological Wastes BIWAED, Vol. 33, No. 3, p 169-179, 1990. 8 fig, 2 tab, 14 ref.

Descriptors: \*Biodegradation, \*Wastewater reactors, \*Wastewater treatment, Adsorption kinetics, Batch treatment, Biomass, Chemical oxygen

demand, Microbial degradation, Mixed liquor solids, Volatile solids.

A laboratory-scale sequencing batch reactor was fed with synthetic wastewater based on sucrose to determine the biokinetics of the process. The values for maximum specific removal rate (u-max) and half-saturation constant (K-s) were found to be 0.32/hour and 563 mg/L, respectively, while the vield constant was determined to be 0.656 with a standard deviation of 0.102. Chemical oxygen demand removal was good. The relationship standard deviation of 0.102. Chemical oxygen-demand removal was good. The relationship be-tween the food:microorganisms (F/M) ratio and sludge volume index (SVI) was explored and re-sults showed that increases in the F/M ratio led to decreases in SVI values. The initial adsorption of decreases in SVI values. The initial adsorption of biomass in the reactor. Comparisons between changes in mixed liquor volatile suspended solids (MVLSS) and total viable count were made, and MVLSS was not found to be a good indicator for the viability of organisms in the reactor. (Author's abstract) W91-02774

PERFORMANCES OF DIGESTERS TREATING THE ORGANIC FRACTION OF MUNICIPAL SOLID WASTES DIFFERENTLY SORTED. Barcelona Univ. (Spain). Dept. of Chemical Engi-

neering.

J. Mata-Alvarez, F. Cecchi, P. Pavan, and P.

Liabres. Biological Wastes BIWAED, Vol. 33, No. 3, p 181-199, 1990. 4 fig, 6 tab, 22 ref. NATO Grant No. 0178/87 and CICYT Project PS87-0018.

Descriptors: \*Anaerobic digestion, \*Municipal wastes, \*Organic matter, \*Solid wastes, \*Waste treatment, Biodegradation, Biogas, Kinetics, Mathematical studies, Methane, Thermodynamics.

When considering the anaerobic digestion of a given waste, both the kinetics and the thermodynamics of the process must be taken into account. The thermodynamic aspect is related to the biodegradability of the waste, and distinguishing between biodegradability and the rate of biodegradability is not seen to be a subject of the real reactor performance, the bioprocess efficiency, defined as the percentage of the maximum biodegradation achievable, is examined. This parameter takes into account the kinetics of the process. biodegradation achievable, is examined. This parameter takes into account the kinetics of the process and the biodegradability. Biodegradation kinetics, measured through a first-order kinetic constant for the source-selected organic fraction municipal solid waste (SS-OFMSW), is around five to ten times larger than that of fresh mechanically-selected OFMSW. The ultimate biogas yield is also 2.5 times larger for SS-OFMSW than for MS-OFMSW Bioprocess efficiency can achieve very large values (around 95 to 99% in both cases). Hydraulic retention time has a small influence on bioprocess efficiency if it is larger than 15 days. Lower yields are obtained if the MS-OFMSW has been precomposted. (Brunone-PTT)

# ACUTE TOXICITY OF HEAVY METALS TO AEROBIC DIGESTION OF WASTE CHEESE WHEY.

Messina Univ. (Italy). Dipt. di Chimica Organica e Biologica

Biologica.
G. Cimino, and C. Caristi.
Biological Wastes BIWAED, Vol. 33, No. 3, p 201-210, 1990. 3 fig, 6 tab, 14 ref.

Descriptors: \*Aerobic digestion, \*Food-processing wastes, \*Heavy metals, \*Toxicity, \*Waste disposal, \*Waste treatment, \*Wastewater treatment, Acidity, Activated sludge, Biochemical oxygen demand, Dairy industry, Synergistic effects.

Cheese whey constitutes a major waste disposal problem for the dairy industry throughout the world. Effects of the acidity and of metal ions on the metabolic activity of activated sludge from waste cheese whey biological treatment, have been determined. The 10% and 50% inhibitory concentrations were evaluated for each ion. In decreasing order of toxicity, two groups were found: Hg(2+)

> Cd(2+) > CrO4(2-) > Cr(3+); and Pb(4+) > Zn(2+). A discrepancy in results from other toxicity studies reveals the impossibility of defining, on an absolute scale, an order of toxicity for these an absolute scale, an order of toxicity for finese ions. A very strong synergistic effect was noted in the mixed copper and zinc studies, revealing the difficulty of setting a water quality standard based on single toxic chemicals. (Author's abstract) W91-02776

METHANOGENIC TOXICITY OF WOOD RESIN CONSTITUENTS.

RESIN CONSTITUENTS.
Agricultural Univ., Wageningen (Netherlands).
Dept. of Water Pollution Control.
R. Sierra-Alvarez, and G. Lettinga.
Biological Wastes BIWAED, Vol. 33, No. 3, p
211-226, 1990. 4 fig, 4 tab, 54 ref.

Descriptors: \*Methanogenesis, \*Resins, \*Wastewater treatment, \*Wood wastes, Anaerobic conditions, Bioassay, Inhibition, Sludge digestion,

The inhibitory effect of representative wood resin compounds on the activity of methanogenic bacteria is evaluated. Resin is, by definition, the mixture of wood components that are extractable with apolar solvents. Major resin constituents are long-chain fatty acids, terpenes, resin acids, lignans, and apolar phenols. The methanogenic inhibition was determined at a temperature of 30 C in standardized toxicity assays utilizing anaerobic granular sludge. An apolar phenol, 4-hydroxystilbene, was the most toxic of the compounds studied, with a 50% inhibiting concentration of 20 mg/L. Resin acids and volatile terpenes were also highly toxic to methanogenic activity. Concentrations causing to methanogenic activity. Concentrations causing 50% inhibition ranged from 43 to 330 mg/L. In contrast, triterpenes were non-toxic at relatively high concentrations, 1000 to 1300 mg/L. These results suggest that wood resin constituents play an important role in the anaerobic inhibition exerted by several forest industry wastewaters. (Author's abstract) W91-02777

# OZONATION OF O-CRESOL IN AQUEOUS SOLUTIONS,

Universidad de Extremadura, Badojoz (Spain).
Dept. de Ingenieria Quimica y Energetica.
F. J. Beltran, J. M. Encinar, and J. F. Garcia-

Araya.
Water Research WATRAG, Vol. 24, No. 11, p 1309-1316, November 1990. 8 fig. 5 tab, 27 ref. Comision Interminsterial de Ciencia y Tecnologia of Spain Grant No. PA85/332.

Descriptors: \*Chemical properties, \*Chemical reactions, \*Cresol, \*Ozonation, \*Wastewater, \*Wastewater treatment, Flux rate, Hydrogen ion concentration, Kinetics, Mass transfer, Partial preserved. sure, Temperature effects.

The o-cresol aqueous solution ozonation of con-centrations similar to those encountered in some wastewaters was studied. The ozone concentration wastewaters was studied. The ozone concentration was measured in the gas stream, iodometrically. During the absorption, ozone at the reactor outlet was also determined by the same procedure. In this way, the ozone absorption rate could be evaluated from the difference between the ozone molar flux rates at the reactor inlet and outlet. The degradarates at the reactor thiet and outset. In eggradation rate of o-cresol increased with temperature, pH, gas flow rate, agitation speed and ozone partial pressure. For a 0.001 M initial concentration of o-cresol a mass rate of 11.7 mg of ozone per minute leads to o-cresol conversions of about 70% in less than 20 min of ozonation, the liquid side mass transfer coefficient for the cuprous chloride-oxygen system (m/s) of the reactor is between 2.8 and 13.0/h. From the variation observed in the o-cresol ozonation yield with time a competitive effect of secondary reaction was shown. The ozone absorption rate was always higher than 3 times the maximum ozone absorption in organictimes the maximum ozone assorption in organic-free water (value defined as reaction factor). This finding indicates that the reactions involved in the proximity of the gas-liquid interface and the kinetic regime is fast. (Author's abstract) W91-02783

#### **Group 5D-Waste Treatment Processes**

ELECTROLYTIC DECOMPOSITION OF CYA-NIDE EFFLUENT WITH AN ELECTRO-CHEMICAL REACTOR PACKED WITH STAINLESS STEEL FIBER.

STAINLESS STEEL FIBER.

National Tsing Hua Univ., Hsinchu (Taiwan).

Dept. of Chemical Engineering.

S. P. Ho, Y. Y. Wang, and C. C. Wan.

Water Research WATRAG, Vol. 24, No. 11, p. 1317-1321, November 1990. 10 fig, 9 ref.

Descriptors: \*Cyanide, \*Electrolysis, \*Packed beds, \*Wastewater reactors, \*Wastewater treat-ment, Copper, Electrical resistance, Energy con-sumption, Silver nitrate, Titration.

An investigation was conducted to determine the feasibility of using a packed-bed electrochemical reactor with stainless steel fiber as electrodes to decompose cyanide-containing effluent. The analysis of cyanide variation during the electrolysis was made by standard titration method with AgNO3.
The copper content was measured via atomic absorption spectroscopy. Every layer of the electrode was packed with 2 cm of stainless steel fiber. The anode and cathode layers were separated by a perforated lucite 12 cm diameter plate. The current perforated lucite 12 cm diameter plate. The current collector was of the same shape and dimension as the plate and located on top of the separator. The results indicate that it is possible to reduce the cyanide content from 1400 mg/L to below 20 mg/L within 4-20 h with a 5-13 kw h/kg CN energy consumption. The cyanide destruction rate increased as the current was increased. It was found that the high current efficiency coupled with the that the high current efficiency coupled with the low electrical resistance advantage due to the multiple layer electrode set-up results in a lower energy consumption than the conventional packed-bed reactor. The process can be accelerated with the existence of copper ions. (White-Reimer-PTT) W91-02784

PERIPHYTON ASH WEIGHT ESTIMATION FROM RESIDUE NOT DIGESTED AFTER HACH METHOD OF KJELDAHL PROTEIN NITROGEN ANALYSIS.
Victoria Univ. (British Columbia). Dept. of Biol-

For primary bibliographic entry see Field 7B. W91-02785

MICROBIAL NUMBERS AND ACTIVITY DURING INFILTRATION OF SEPTIC-TANK EFFLUENT IN A SUBSURFACE SAND

FILTER. Sveriges Lantbruksuniversitet, Uppsala. Institu-

Sveriges Latitutussimiversitet, Oppsain. Institu-tionen foer Mikrobiologi. M. Pell, F. Nyberg, and H. Ljunggren. Water Research WATRAG, Vol. 24, No. 11, p 1347-1354, November 1990. 1 fig, 7 tab, 34 ref.

Descriptors: \*Adenosine triphosphate, \*Microbial degradation, \*Nutrient removal, \*Sand filters, \*Septic tanks, \*Wastewater treatment, Biochemical oxygen demand, Carbon dioxide, Chemical oxygen demand, Infiltration, Nitrogen, Phosphorus. Sweden.

A subsurface, 4-person sand-filter system for treating septic-tank effluent was subjected to conventional water analysis and to an extended microbial analysis of the filter material. Measured rates of CO2 production in the filter media suggest that the system has a good microbial capacity to degrade the organic matter in wastewater; the volume efthe organic matter in wastewater; the volume effectively treated depends on the BOD (e.g. 951 sq m/d at a BOD of 169 mg/L and 2851 sq m/d at a BOD of 74 mg/L). The actual load was 40 to 801 sq m/d. Based on viable counts of bacteria the amounts of P and N bound in the 13 +/-10 g dw/sq m viable biomass were calculated to correspond at the viable biomass were calculated to correspond to the viable biomass were calculated to correspond. sq m viable biomass were calculated to correspond to the amounts produced by 1 person in <2 days. From the ATP levels in the sand, the active biomass was calculated to be 19 +/-15 g dw/sq m, indicating that the viable biomass also gives an accurate estimate of the active biomass. The levels of ATP in the sand-filter surface revealed that the loading of wastewater occurred unevenly. The high numbers of ammonium-oxidizing bacteria and denitrifying bacteria in the surface layer show that the system was predominantly operating aerobically and had a high potential for removing nitrogen.

The microbial techniques used were sensitive one microbial techniques used were sensitive enough to detect the decrease in biomass that occurred with increasing depth. Reduction of COD, P and N in the wastewater during infiltra-tion were estimated to be 86, 70, and 60% respection were estimated to be 50, N, and 00% respectively. These figures are considered to be overestimates, since analysis of Cl(·) showed that groundwater had leaked into the bed, diluting the effluent water. A correction factor for the dilution effect water. A correction factor for the diffulon effect was therefore introduced. In addition, N and P from the surrounding arable land periodically leaked into the bed. The environment in the sand filter was sufficiently stable to ensure high microbial activity; thus the purifying capacity of septicatank effluent should remain high throughout the year. (Author's abstract) W91-02789

SIMPLE METHOD TO DISTINGUISH BETWEEN POLYPHOSPHATE AND OTHER PHOSPHATE FRACTIONS OF ACTIVATED SLUDGE.

Technische Univ., Dresden (German D.R.). Sektion Wasserwe

D. Uhlmann, I. Roske, M. Hupfer, and G. Ohms. Water Research WATRAG, Vol. 24, No. 11, p 1355-1360, November 1990. 8 fig, 1 tab, 16 ref.

Descriptors: \*Activated sludge process, \*Analytical methods, \*Phosphates, \*Polyphosphate, cal methods, \*Phosphates, \*Polyphosphate,
\*Wastewater analysis, \*Wastewater treatment,
Fractionation, Lake sediments, Mixed liquor solids, Organophosphorus compound, Physicochemical

The Psenner procedure of sequential extraction steps to quantify ecologically relevant phosphate fractions in lake sediments was applied to activated sludge from waste treatment plants for biological phosphate removal. The principal goal was to distinguish between proportions of chemical/physico-departical and biochemical processes in treatment. tinguish between proportions of chemical/physico-chemical and biochemical processes in treatment plants with biological phosphate elimination. Using this method the phosphate fractions that may be distinguished are: (1) redox-sensitive phosphate, mainly bound to Fe(OH)3; (2) phosphate adsorbed to surfaces (Al2O3), exchangeable against OH(-), and alkali-soluble phosphate; (3) phosphate bound to CaCO3, MgCO3 and apatite; and (4) a fraction which hitherto was designated 'organically bound phosphate. By means of nuclear magnetic resonance spectroscopy and by inclusion of a hot water extraction step it became evident that the 'organically bound phosphate' mainly contained polyphosphate (PP). In activated sludge samples with phosphate-accumulating bacteria, the PP content amounted to 80 mg/g mixed liquor volatile susamounted to 80 mg/g mixed liquor volatile sus-pended solids. The difference in the PP concentration caused by an alternation of anaerobic and aerobic conditions (which is characteristic of bioaerobic conditions (which is characteristic of bio-logical phosphate removal) was reflected by corre-sponding differences in the proportion of the NaOH fraction. By combination of the Psenner fractionation and hot water extraction, indications of a significant proportion of PP in lake sediments have been found. (Author's abstract) W91-02790

ACTIVATED SLUDGE PROCESS: A PROPOSED METHOD TO PREDICT PROCESS PA-DAMETERS

W. H. Chapman. Water Research WATRAG, Vol. 24, No. 11, p 1361-1363, November 1990. 4 ref.

Descriptors: \*Activated sludge process, \*Middle East, \*Temperature effects, \*Wastewater facilities, \*Wastewater treatment, Design criteria, Mathematical models, Mixed liquor solids, Oxygen, Processing of the Activation of the Computer of

Sewage treatment plants in the Middle East operate on a wide temperature range which necessitates a revised approach to process control. Observations made while running these sewage treatment plants were used to develop a theory on activated sludge and to illustrate how the theory can be used to aid both operation and design of activated sludge plants. It was observed that as the ambient temperature increases, the sludge production and the power required for the process increase. If the

mass balance for an activated sludge plant is then considered, and the system is in equilibrium, the material entering the plant is: (1) discharged in the considered, and the system is in equilibrium, the effluent; (2) removed as surplus sludge; or (3) destroyed by respiration in the sludge. Equations subsequently derived to describe these relationships can be used to predict the operation of an activated sludge plant under varying site conditions. When a plant is being designed it is necessary to know the mean cell residence time (MCRT) for plant operation in order to calculate the respiration rate and the BOD load per K of mixed liquor solids at maximum and minimum temperatures. These figures can then be used to predict the surplus sludge produced and the power required under specific conditions. The variation in oxygen required and thus the degree of adjustment required on the aeration system can then be determined. When a plant is operated at constant mixed liquor solids, the power required varies to a greater degree than if the MCRT is kept constant. Allowing the mixed liquor solids to increase in winter within reasonable limits allows better use to be made of sludge treatment facilities. (White-Reimermade of sludge treatment facilities. (White-Reimer-PTT) W91-02791

KINETIC STUDY ON METHANOGENESIS BY ATTACHED BIOMASS IN A FLUIDIZED BED. Kyushu Univ., Fukuoka (Japan). Dept. of Civil Engineering.

T. Kuba, H. Furumai, and T. Kusuda Water Research WATRAG, Vol. 24, No. 11, p 1365-1372, November 1990. 8 fig, 6 tab, 11 ref.

Descriptors: \*Fluidized beds, \*Kinetics, \*Methanogenesis, \*Wastewater reactors, \*Wastewater treatment, Biomass, Comparison studies, Fatty acids, Growth rates, Model studies.

The growth kinetic constants and the concentration of 'active' attached biomass in an anaerobic fluidized bed, which decomposes acetic, propionic and butyric acids were estimated. The fluidized bed was operated as a methanogenic reactor with synthetic zeolite as support medium. The reactor was supplied with synthetic wastewater (1000 mg COD/L), a mixture of volatile fatty acids (VFA), in the range of hydraulic retention time (HRT) from 0.25 to 2 days. After the effluent reached a steady state in quality, batch experiments in the bed reactor were conducted using acetic, propionic and butyric acids as substrate in order to investigate the decomposition characteristics of each substrate by the attached biomass. Detached biomass from the support media was also used in batch The growth kinetic constants and the concentrafrom the support media was also used in batch experiments under the completely mixed condition in order to estimate parameter values of the growth kinetics of the bacteria. The changes of fatty acid concentrations with time were expressed the Monod growth model. The two kinetics parameters, maximum specific growth rates and saturation constants, and 'active' biomass concen-trations were obtained by the curve fitting method. The comparison of the measured concentration of volatile suspended solids (VSS) and protein with the estimated 'active' biomass concentrations indi-cated that a large amount of inert organic matter exists in the attached growth reactor. (Author's W91-02792

REDUCTIONS OF ENTERIC MICROORGA-NISMS DURING AEROBIC SLUDGE DIGES-

Cornell Univ., Ithaca, NY. Center for Environmental Research.

mentai Research.

J. H. Martin, H. E. Bostian, and G. Stern.

Water Research WATRAG, Vol. 24, No. 11, p
1377-1385, November 1990. 4 fig, 10 tab, 20 ref.

USEPA Cooperative Agreement CR-811776.

Descriptors: \*Aerobic digestion, \*Enteric bacteria, \*Enteroviruses, \*Sludge digestion, \*Wastewater treatment, Coliforms, Comparison studies, Fecal streptococci, Mathematical equations, Tempera-

Seasonal variations in the reductions of total coliform, fecal streptococci and enterovirus densities

# Waste Treatment Processes—Group 5D

that occur during conventional aerobic sludge di-gestion in cold climates were characterized. In gestion in cold climates were characterized. In addition, the potential for reduction in the densities of these four groups of enteric microorganisms in cold climates by simple modifications that increase process temperature by reducing heat losses was demonstrated. To obtain the data, two 32 cu m aerobic digesters located at a small municipal wastewater treatment along wastewater restricted. wastewater treatment plant were operated continuously over a period of 20 months. One digester was a conventional digester while the other was designed to minimize heat losses and thus, facilitate autoheating. When the results obtained during 11 separate periods of steady-state operation at mean mixed liquor temperatures ranging from 8 to 40 C and at residence times of 10, 15, and 20 days were combined for analysis, it was evident that significant reductions in the densities of the four gr of enteric microorganisms were dependent on both residence time and temperature. Using the Arrhen-ius equation, it was possible to describe mathematically the temperature dependence of the rate of log10 reduction in density of each of these four groups of enteric microorganisms. The four mathematical relationships developed provide a rational basis to determine residence times necessary to achieve desired levels of indicator organism and enterovirus reductions during aerobic sludge diges-tion at mixed liquor temperatures ranging from 8 to 40 C. (Author's abstract) W91-02794

INACTIVATION OF BACTERIOPHAGE MS2 IN WASTEWATER EFFLUENT WITH MON-OCHROMATIC AND POLYCHROMATIC UL-TRAVIOLET LIGHT. Rijksinstituut voor de Volksgezondheid en Milieu-hygiene, Bilthoven (Netherlands). Lab. for Water and Food Microbiology.

hygiene, Bilthoven (Netherlands). Lab. for Water and Food Microbiology. A. H. Havelaar, C. C. E. Meulemans, W. M. Pot-Hogeboom, and J. Koster. Water Research WATRAG, Vol. 24, No. 11, p 1387-1393, November 1990. 9 fig, 1 tab, 13 ref.

Descriptors: \*Bacteriophage, \*Disinfection, \*Ultraviolet radiation, \*Viruses, \*Wastewater treatment, Calibrations, Kinetics, Lambert-Beers Law, Mathematical models.

A model using bacteriophage MS2 for the calculation of the effective dose in u.v.-disinfection by polychromatic light from a medium pressure mercury lamp was studied. The model was based on first-order inactivation kinetics, the u.v.-absorption spectrum of MS2-RNA as the action spectrum and Lambert-Beer's law for light absorption by the effluents. The u.v.-sensitivity of the phage was calibrated with a low pressure mercury lamp; the inactivation rate constant (k) was 0.0106 sq m/J, which corresponded well with previously reporteriously which corresponded well with previously reported data. The model fitted actual data in most experiments, although tailing effects were observed. In some experiments a different value of k was necessome experiments a different value of k was necessary to fit the actual inactivation curves, varying between 0.0077 and 0.0121 sq m/J. The repeatability of inactivation experiments with RNA-bacteriophages appears to be good, which is an advantage when proposing these organisms as biological standards for calibration of 50 v-lamps and disinfection units. (Author's abstract) W91-02795

ROLE OF RESIN ACIDS IN THE ANAEROBIC TOXICITY OF CHEMITHERMOMECHANICAL PULP WASTEWATER. Ottawa Univ. (Ontario). Dept. of Civil Engineer-

ing. P. J. McCarthy, K. J. Kennedy, and R. L. Droste. Water Research WATRAG, Vol. 24, No. 11, p 1401-1405, November 1990. 5 fig, 2 tab, 10 ref.

Descriptors: \*Industrial wastewater, \*Pulp and paper industry, \*Pulp wastes, \*Resin acids, \*Toxicity, Anaerobic toxicity assay, Bacteria, Chemithermomechanical pulp, Methanogenesis, Synergistic

Chemithermomechanical pulp (CTMP) wastewaters are treated anaerobically, in full scale operations, in spite of the presence of inhibitory compounds. These compounds have not been well

identified nor placed in an order of priority in identified flor piaced in an order of priority in terms of inhibitions to anaerobic bacteria. There-fore, anaerobic toxicity assays (ATA) were used to quantify the relative toxicity of resin acids to the total toxicity in bleached CTMP (BCTMP) wastewater. A resin acid mixture was prepared wastewater. A resin acid mixture was prepared that matched as closely as possible the mean resin acid composition reported in wastewater from the Quesnel River Pulp Co. on five separate occasions. A series of resin acid concentrations ranging from 20 to 700 mg/L were assayed during the ATA. Resin acids were partitioned between the soluble wastewater and the fiber fractions. Therefore fiber wastewater and the fiber fractions. Therefore fiber toxicity was also compared to raw BCTMP wastewater toxicity. Results indicated that anaerobic toxicity in BCTMP with fiber wastewater is partly soluble and partly fiber associated. The anaerobic toxicity that is removed with the fiber is methanol soluble. The bulk of the fiber which is not methanol soluble exhibited no toxicity to the anaerobic cultures used. Resin acids inhibit anaerobic cultures used. Resin acids inhibit anaerobic cultures used. anaerobic cultures used. Resin acids inhibit anaerobic activity but BCTMP wastewater toxicity to anaerobic bacteria can only be partially explained by the presence of resin acids. The possible synergistic effects that other compounds may have in conjunction with the resin acids in BCTMP with fiber wastewater toxicity could not be excluded. (White-Reimer-PTT) W91-02797

PHOTOCATALYTIC DEGRADATION OF OR-GANOPHOSPHOROUS INSECTICIDES AQUEOUS SEMICONDUCTOR SUS SIONS

National Chemical Lab. for Industry, Yatabe

(Japan).
K. Harada, T. Hisanaga, and K. Tanaka.
Water Research WATRAG, Vol. 24, No. 11, p 1415-1417, November 1990. 6 fig, 12 ref.

Descriptors: \*Catalysts, \*Insecticides, \*Organo-phosphorus pesticides, \*Photolysis, \*Wastewater treatment, Chemical treatment, Degradation prod-ucts, Degradation rates, Formaldehyde, Hydrogen peroxide, Photocatalytic degradation

A method was sought to improve the efficiency of the photocatalytic process for the degradation of the photocatalytic process for the degradation of organic and inorganic substances in wastewater. Two organophosphorus insecticides, dimethyl-2,2-dichlorovinyl phosphate (DDVP) and dimethyl-2,2-trichloro-1-hydroxyethyl phosphonate (DEP), were degraded in the presence of suspended TiO2 by illumination with a super-high pressure mercury lamp or by exposure to sunlight. Pt-loading to TiO2 enhanced the degradation rates 4.5 for DDVP and 6-fold for DEP. The addition of H2O2 to the surression also enhanced the rates 10-fold to the suspension also enhanced the rates 10-fold for DDVP and 2-fold for DEP. The final degradation products were Cl(-), PO4(3-), H(+) and CO2, and one of the intermediates was formaldehyde. (Author's abstract) W91-02799

IONIC STRENGTH IN DEEP BED FILTRA-TION. Asian Inst. of Tech., Bangkok (Thailand). Div. of

Asian inst. of 1 (ct.), pangkov (1 manano). 271. St. Environmental Engineering.

J. S. Chang, and S. Vigneswaran.

Water Research WATRAG, Vol. 24, No. 11, p 1425-1430, November 1990. 4 fig. 3 tab, 15 ref.

Descriptors: \*Deep bed filtration, \*Filtration, \*Ionic strength, \*Ions, \*Wastewater treatment, Conductance, Particulate matter, Removal efficiency, Sodium chloride, Zeta potential.

The removal efficiency of particles in deep bed filtration depends on both transport and attachment mechanisms of particles. The particle attachment mechanisms depend mainly on chemical characteristics of aqueous phase, suspended particles and filter media. Two different suspensions were used to study the effect of ionic strength on the particle removal efficiency. The ionic strength of suspension was varied by adding a known amount of sodium chloride. The removal efficiencies were related to joinic strength and zeta potencies were related to ionic strength and zeta poten-tial. Most of the suspended particles found in water and filter grain used in deep bed filtration carry negative charges which produce a repulsion force

that can be measured in terms of the zeta potential. The zeta potential gets closer to zero the higher the filter removal efficiency. Two different zones were observed when the initial collection efficienwere observed when the initial collection efficien-cy was platted against the concentration of electro-lyte (ionic strength). For ionic strength lower than a certain value of NaCl concentration (in this study less than 0.219 mol/L), the variation of the initial less than 0.219 mol/L), the variation of the initial collection efficiency was significant even for a small change in ionic strength; for ionic strength above this value the initial collection was constant. The clean filter bed efficiency and removal efficiency during the ripening period for various strengths were quantitatively related to the two model coefficients appearing in the O'Melia-Ali model. These model coefficients represent the filter medium-particle and particle-particle attachments. This type of quantification of the effect of ionic strength in terms of filter efficiency is very useful in filter design and operation control. (Author's abstract) abstract) W91-02801

MODELING TRANSIENT SUBSTRATE LOADS IN COMPLETELY MIXED AERATION BASINS AT HYDRAULIC STEADY STATE.

Vanderbilt Univ., Nashville, TN. Dept. of Civil and Environmental Engineering.
V. J. Boero, A. D. Koussis, and A. R. Bowers. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 8, p 695-708, 1990. 4 fig, 11 ref.

Descriptors: \*Activated sludge process, \*Environmental engineering, \*Model studies, \*Substrates, \*Wastewater treatment, Aerated lagoons, Biomass, Computer programs, Differential equations, Model testing, Monod term, Numerical models.

In many engineering fields it is common practice to use simple models for design purposes. In envi-ronmental engineering it is customary to design biological treatment systems on the basis of stedy state reactor behavior, which is inadequate for the biological treatment systems on the basis of steady-state reactor behavior, which is inadequate for the study of treatment systems under operational conditions. The description of transient behavior requiring the use of differential equations, increases the modeling effort substantially. A numerical technique for predicting the response of a completely mixed activated sludge system (with recycle) to transient substrate inputs has been developed. Substrate utilization and biomass growth were modeled by Monod kinetics. Computational efficiency is achieved by 'locally linearizing' the Monod expression, and by decoupling the two mass balances by assuming biomass to be constant locally over a time step. The subsequent solutions are simple and ideally suited for personal computers. Comparisons with numerical solutions of the complete equations show a high degree of accuracy and robustness for the proposed technique. (Author's abstract)

EFFECTS OF CHEMICAL PHOSPHORUS PRECIPITATION ON ANAEROBIC DIGES-

Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering. S. Yeoman, J. N. Lester, and R. Perry. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 8, p 709-720, 1990. 6 fig. 2 tab, 30 ref.

Descriptors: \*Anaerobic digestion, \*Biological wastewater treatment, \*Chemical precipitation, \*Phosphorus removal, \*Sludge digestion, \*Wastewater treatment, Activated sludge, Alkalinity, Alum sludge, Aluminum sulfate, Methane.

The use of chemicals such as aluminum sulfate and ferric chloride in biological wastewater treatment can achieve excellent phosphorus removals; however, it can also influence the process of anaerobic ever, it can also influence the process of anaerobic digestion. Results from the operation of laboratory scale anaerobic digesters using chemically precipitated sludges indicated that such treatment had detrimental effects on digester operation. A digester that only contained 25% precipitated activated sludge and the control were similar in terms of performance, because the sludge concentration was not high enough to affect performance signifi-

# **Group 5D—Waste Treatment Processes**

cantly. It was concluded that alum and ferric chlocantly. It was concluded that alum and ferric chloride used for the precipitation of phosphorus do adversely affect anaerobic digestion, especially in terms of methane production and alkalinity. However, this could be overcome if co-precipitation was used and the majority of sludge sent to anaerobic digestion (approximately 75% depending on works practice) is chemically untreated. (Fish-PTT) PTT) W91-02823

IMPACT OF NITROGEN ON THE ADSORP-TIVE CAPACITY OF ACTIVATED CHAR-

University of Petroleum and Minerals, Dhahran (Saudi Arabia). Dept. of Civil Engineering. For primary bibliographic entry see Field 5F. W91-02825

DEGRADATION OF BLUE GREEN ALGA, MICROCYSTIS AERUGINOSA BY FLAGELLATA, MONAS GUTTULA. Ibaraki Prefecture Inst. of Public Health, Mito

For primary bibliographic entry see Field 5F. W91-02826 (Japan).

CHARACTERIZATION OF BACTERIAL BIO-MASS POTENTIAL ACTIVITY BY PROTEO-LYTIC ACTIVITY MEASUREMENTS.

des Sciences de l'Environment, Metz

(France). P. Bauda, C. Bouzendorffer, J. C. Block, G. Faup, and F. Colin.

Environmental Technology (Letters) ETLEDB, Vol. 11, No. 8, p 785-792, 1990. 5 fig, 2 tab, 13 ref.

Descriptors: \*Activated sludge process, \*Bacterial analysis, \*Biomass, \*Enzymes, \*Wastewater treatment, Artificial substrates, Assay, Biodegradation,

To control biomass activity within any process (e.g. fermentation or activated sludge in wastewater treatment), it is necessary to choose enzymatic activities not only representative of the physiological state of the bacterial cells but also easy to measure. Phosphatase, glycosidase, and protease activities are possible candidates for this state was they were shown to respond to environassay as they were shown to respond to environ-mental stress such as starvation or poisoning. Bac-terial protease activity was assayed using L Leu-cine beta naphthylamide as artificial substrate. Apparent KM values ranging from 112 to 606 micro-moles of substrate consumed/g of biomass (dry weight) were obtained with activated sludge samples. Specific activities were in the range from 7 to 26 micromoles of substrate consumed/min/g of sludge (dry weight). It was established that proteolytic activity from various bacterial populations can be conveniently measured at 30 C and pH 8.5. In these conditions, the substrate and product molecules of the protease assay are nonbiodegradable, nontoxic, and not significantly adsorbed by the biomass. (Author's abstract)

W91-02830

HEAD LOSSES IN STORM SEWER MAN-HOLES: SUBMERGED JET THEORY. Technical Univ. of Denmark, Lyngby. Inst. of Hydrodynamics and Hydraulic Engineering. For primary bibliographic entry see Field 8B. W91-02916

DECONTAMINATION TECHNOLOGIES FOR RELEASE FROM BIOPROCESSING FACILITIES: PART V. DECONTAMINATION OF SLUDGE.
Battelle Memorial Inst., Columbus, OH. Environ-

mental Science Dept.

G. B. Wickramanayake. CRC Critical Reviews in Environmental Control CCECAU, Vol. 19, No. 6, p 515-537, 1990. 1 fig,

Descriptors: \*Chemical treatment, \*DNA, \*De-contamination, \*Gamma radiation, \*Incineration, \*Microwaves, \*Pharmaceutical wastes, \*Sludge

treatment. \*Thermal radiation. \*Wastewater treatment, Cost analysis, Sludge analysis, Sludge solids Suspended solids

Sludge generated at recombinant DNA processing facilities consists mainly of biological solids such as cells and cell debris. The solid levels in the sludge samples can vary depending on the process used to concentrate solid materials. The solids content and concentrate soul materias. The soulds content and physical properties of sludge will affect the selec-tion of an appropriate decontamination agent. Po-tential techniques for sludge decontamination in-clude incineration, thermal (dry-heat and steam) treatment, gamma and electron radiation, micro-wave radiation and chemical decontamination. Each of these techniques on microbial inactivation can be effective in the treatment of recombinant DNA sludge. However, the required dosage for DNA stuage. However, the required adoage for each of these procedures needs to be established on a case-by-case basis. Depending on the sludge characteristics, volume and treatment cost, the need for pretreatment or combined treatments should also be evaluated. Since the verification of the extent of decontamination is extremely difficult nne extent or decontamination is extremely difficult with sludges, high safety factors should be incorporated during the design of treatment units and good maintenance and operating procedures employed. (See also W91-02937) (Medina-PTT) W91-02936

DECONTAMINATION TECHNOLOGIES FOR RELEASE FROM BIOPROCESSING FACILITIES: PART VI. VERIFICATION OF WASTEWATER DECONTAMINATION. Battelle Memorial Inst., Columbus, OH. Environ-mental Science Dept.

G. B. Wickramanayake. CRC Critical Reviews in Environmental Control CCECAU, Vol. 19, No. 6, p 539-555, 1990. 2 fig, 5 tab, 29 ref. EPA Contract No. 68-03-3248.

Descriptors: \*DNA, \*Decontamination, \*Hazard assessment, \*Microorganisms, \*Pharmaceutical wastes, \*Statistical analysis, \*Sterilization, \*Wastewater treatment, Effluent streams, Waste

Wastes generated in bioprocessing facilities can be decontaminated using chemical and physical agents commonly employed in wastewater disinfection and sterilization processes. The decontamination process involves inducing irreversible loss of viability to the organism and its subcellular components, such as genetic elements, if necessary The extent of decontamination or the permissible levels of recombinant DNA microorganisms in the final effluent is governed by the acceptable risk associated with the organism of concern. For biological agents with a high degree of risk, sterility can be the targeted treatment end point. Because of the limitations associated with sampling and viabil-ity assessment techniques, the sterility of a waste stream cannot be absolutely verified. At best, the waste stream can be shown to contain less than a given number of microbes at a desired confidence limit. Binomial probabilities can be used to make statistical inferences from verification test results. Large sample sizes (total numbers of samples) are required to verify high levels of decontamination. Statistically, the total volume of the waste stream has little or no effect on the selection of sample size to determine a certain concentration of micro organisms. The frequency of conducting verifica-tion tests depends on the risk level associated with tion tests depends on the risk level associated with the organism and the variability of waste charac-teristics and operating parameters of the decon-tamination system. The validity of verification test results has a significant bearing on the viability-assessment method. Any concentration or recov-ery methods to improve the sensitivity of this ery includes of improve the sensitivity of this technique should be employed with caution because such techniques can have adverse impacts in the accuracy of results. Because almost all of the detecting and monitoring techniques are based on the culturability of organisms, such in vitro tests have to be representative of the viability of the organism. If biological indicators are used to verify organism. It biological indicators are used to verify sterility, such organisms (1) need to be more resist-ant than the rDNA organism, (2) should be able to be detected at low concentration and (3) should not pose a health risk. (See also W91-02936) (Medina-PTT)

W91-02937

LOW-TECH, LOW-COST SOLUTION TO TREATMENT IN ST. IGNACE, MICH.

Granger and Associates, Inc., St. Ignace, MI. G. R. Hampton.

Water Environment & Technology WAETEJ, Vol. 2, No. 9, p 6-11, September 1990.

Descriptors: \*Clean Water Act, \*Michigan, \*Wastewater disposal, \*Wastewater facilities, \*Wastewater treatment, Acrators, Effluents, Endangered species, Forests, Gravity flow, Lake Huron, Lake fisheries, Wastewater lagoons, Wet-

A new wastewater treatment plant in St. Ignace, Michigan, was designed to provide low-cost, simple to operate, and not requiring advanced technical educational backgrounds for its personnel to maintain it. This project was patterned after unique wastewater-disposal problems resulting from the area's fluctuating population and harsh winters, while addressing concern for the area's forests, wetlands, endangered species, high quality lake trout waters, and archaeological sites. This plant operates on a relatively simple aerated lagoon process with gravity flow, which precludes the need for pumps. The wastewater treatment process involve surface aspirators using guidelines developed for dual-power level lagoons in the southeast USA. Effluent is detained for half a day in a final polishing pond for additional clarification before it is disinfected by UV. A cascade waterfall aerator raises the dissolved oxygen content of the effluent before discharge to Lake Huron. The new wastewater treatment plant was placed online in June 1988, just before the July 1 deadline for secondary treatment under the Clean Water Act. From the outset, the plant met discharge limits for secondary treatment set by the Michigan Department of Natural Resources. However, operational problems related to the chemical feed system for the phosphotr removal process caused effluent phosphorus levels to exceed the 1.0 mg/L limit for a short period. Adjustments were successfully made to correct this problem. (Medina-PTT)

SITING AND TECHNOLOGY POSE CHAL-LENGES FOR COMMUNITIES ENDING OCEAN DISPOSAL OF SLUDGE.

Black and Veatch, Inc., Cambridge, MA.

G. F. Shimp.

Water Environment & Technology WAETEJ, Vol. 2, No. 9, p 38-42, September 1990. 1 tab.

Descriptors: \*Administrative agencies, \*Boston, \*Digested sludge, \*Massachusetts, \*Public opinion, \*Sludge disposal, \*State jurisdiction, \*Wastewater facilities, Education, Legislation, Sludge solids,

Phasing out ocean disposal of wastewater sludge and choosing alternate sites to dispose of the sludge require cities to make unpleasant accommodations in solving this example of an environmental problem. Such is the case in Northeastern coastal cities like Boston, Massachusetts. Twice daily, dispeted sludge from the two primary treatment plants serving Boston and 42 neighboring cities and towns is flushed into the shallow waters of Boston Harbor on the outgoing tides. Studies in the early 1970s concluded that 25-30% of the discharge solids return and settle out in the harbor the early 1970s concluded that 25-30% of the discharge solids return and settle out in the harbor floor. Since that time, several plans were developed for sludge disposal by other means, but none were implemented because the public and regulatory agencies did not support the recommended technology or the siting choice. Finally, under court pressure, the state legislature in early 1985 formed the Massachusetts Water Resource Authority (MWRA) to take charge of the harbor cleanup. Studies made by this agency indicated that the most effective tool for educating the public about sludge management technologies is information about similar systems in other communities and how it would apply to the local situanities and how it would apply to the local situa-tion. Also, after weighing public comments, the MWRA enhanced its credibility and public image

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by dealing decisively on ruling out incineration, in spite of regulatory pressure for continued contingency planning, and agreeing to drop composting in favor of another reuse technology with better odor control in spite of potentially higher cost. (Medina-PTT)

TWO DECADES OF PROGRESS.

PRICADES OF PROGRESS.
Fairfax County Dept. of Public Works, Lorton,
VA. Wastewater Treatment Div.
For primary bibliographic entry see Field 5G.
W91-02957.

CARBON COLUMNS VS. THE PACT PROCESS FOR PRIORITY-POLLUTANT REMOVAL. Du Pont de Nemours (E.I.) and Co., Deepwater, NJ. Chambers Works.

NJ. Chambers Works.
G. J. O'Brien, R. A. Reich, L. S. Salata, M. H.
Feibes, and C. N. McManus.
Water Environment & Technology WAETEJ,
Vol. 2, No. 9, p 72-75, 238-240, September 1990. 5
fig, 2 tab, 6 ref.

Descriptors: \*Activated carbon, \*Biodegradation, \*Carbon filters, \*Chemical wastewater, \*Delaware River, \*New Jersey, \*Patents, \*Wastewater facilities, \*Wastewater treatment, \*Water quality standities, \*Water ards Cost analysis

At Chambers Works, a large, diversified, organic chemicals plant at Deepwater Point in southern New Jersey, Du Pont operates a 40 mgd wastewater treatment plant to remove pollutants from aqueous wastes generated on site and at other Du Pont plants and commercial facilities. Com-mercial wastes received from 32 states and about 85% of New Jersey's liquid hazardous wastes that 85% of New Jersey's Iquid hazardous wastes that are shipped to non-municipal treatment facilities are treated by a combination of biodegradation and in-situ carbon adsorption, a patented powdered activated carbon treatment (PACT) process. The water quality of the effluent discharged to the water quality of the effluent discharged to the Delaware River is closely monitored under a New Jersey pollutant discharge elimination system permit which, in June 1991, will incorporate limits on 57 organic priority pollutants covered under the Organic Chemicals, Plastics, and Synthetic Fibers (OCPSF) guidelines. Because some compounds have historically been above the guideline limits, a study was made to find an alternative end-of-pipe-line treatment or to determine the compounds that require source treatment. Two treatment technologies were considered and commared: carbon colories were considered and commared: carbon colrequire source treatment. I wo treatment techno-ories were considered and compared: carbon col-umns and expanding the existing PACT process by adding a second PACT stage. Experimental data favored addition of a second PACT stage over carbon columns for higher performance and lower investment cost. (Medina-PTT) W91-02958

#### 5E. Ultimate Disposal Of Wastes

SOIL AND VEGETATION RESPONSES TO SEWAGE SLUDGE ON A DEGRADED SEMI-ARID BROOM SNAKEWEED/BLUE GRAMA PLANT COMMUNITY.

PLANT COMMUNITY.

Rocky Mountain Forest and Range Experiment Station, Albuquerque, NM.

P. R. Fresquez, R. E. Francis, and G. L. Dennis.

Journal of Range Management JRMGAQ, Vol. 43, No. 4, p 325-331, July 1990. 6 tab, 40 ref.

Descriptors: \*Land disposal, \*Plant growth, \*Semiarid climates, \*Sludge disposal, \*Soil amend-ments, \*Soil chemistry, Heavy metals, Metals, Path of pollutants, Seasonal variation, Sludge drying, Toxicity, Trace elements.

Three rates of dried sewage sludge (22.5, 45.0, and 90.0 megag/ha) were applied to a degraded semi-arid grassland site on the Upper Rio Puerco Wa-tershed in west-central New Mexico. Various soil tersneu in west-central New Mexico. Various soil and plant parameters were determined over four growing seasons. Most soil macronutrients, such as nitrogen, phosphorus, and potassium, and micronutrients, such as copper, iron, manganese, and zinc, increased linearly with increasing sludge amendment rates. Heavy metals (cadmium and lead) did

not change as a result of sludge amendment in the first three growing seasons. However, concentrations of soil cooper, manganese, and cadmium were just above maximum acceptable standards in the heaviest sludge treatment after four growing seasons. Plant density, species richness, and diversity all decreased with increasing sludge rates. sity all decreased with increasing sludge rates. However, total plant foliar cover and herbaceous yields increased significantly with the application of sludge. Blue grams (Boutelous graciis (H.B.K.) Lag.) cover and yields, in particular, increased twofold to threefold over the control as a result of sludge amendment, whereas broom snakeweed sludge amendment, whereas broom snakeweed (Gutierrezia sarothrae (Pursh) Britt. + Rusby) density decreased over four growing seasons. The most favorable soil and vegetation results were from the 22.5 and the 45 megag/ha sludge application rates. The near complete elimination of snakeweed after four growing seasons and the increase in blue grama cover and production as a result of sludge amendment may help to control and/or hinder the reestablishment of snakeweed and/or hinder the reestablishment of snakeweed plants. This study showed that sewage sludge from a nonindustrial city such as Albuquerque can be safely applied to a degraded grassland in the semi-arid Southwest without any apparent adverse environmental effects at sludge rates up to 45 megag/ha. (Brunone-PTT) W91-02076

LEAD, ZINC, CADMIUM, AND FLUORIDE IN SMALL MAMMALS FROM CONTAMINATED GRASSLAND ESTABLISHED ON FLUORO-SPAR TAILINGS.

Sunderland Polytechnic (England). School of Biol-

For primary bibliographic entry see Field 5B. W91-02082

TRACE METAL ANALYSIS OF SEWAGE SLUDGE AND SOILS IN BAHRAIN.
Bahrain Univ., Manama. Dept. of Chemistry.

Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 1/2, p 147-152, May 1990. 2 tab, 16 ref.

Descriptors: \*Bahrain, \*Heavy metals, \*Land disposal, \*Path of pollutants, \*Sludge analysis, \*Sludge disposal, \*Trace metals, Agriculture, Soil amendments, Soil chemistry, Soil contamination,

Trace metals such as lead, zinc, copper, nickel, cadmium, and iron were determined in sewage sludge produced at a sewage treatment plant in Bahrain (Tubli) and soils. The soils, both untreated and treated with the sludge are used for agricultural purposes in Bahrain. The trace metal levels showed the following range (microg/g dry weight): lead, 242 to 609; zinc, 704 to 836; copper, 329 to 512; nickel, 23 to 41; cadmium, 1.8 to 3.9; and iron, 1867 to 4824. The data show the degree to which untreated soils have already been contaminated with trace elements. The level of trace elements found in sludge showed the following range (microg/g dry weight): lead, 140 to 186; zinc, 597 to 836; copper, 348 to 449; nickel, 47 to 35; cadmium, 5.7 to 9.2; and iron, 5950 to 850. Mean levels were generally close or lower than mean concentrations reported in the United Kingdom and the United States for sludge. They were also lower than the suggested concentration limits for application of sludge on agricultural land, also lower than the suggested concentration limits for application of sludge on agricultural land, which is one of the most cost-effective and attrac-tive techniques for sludge disposal. Soils treated with this sludge (after 1 year) were also analyzed and showed substantial enhancement of the availand snowed substantial enhancement of the available level of trace elements in the soil. This enrichment will eventually lead to an increase in the trace element level in plants grown for human or animal consumption, with potential phytotoxic effects, and the possibility of toxic effects on livestock and human beings. (Author's abstract) W91-02088

EFFECT OF SOLID-PHASE SPECIATION ON METAL MOBILITY AND PHYTOAVAILABI-LITY IN SLUDGE-AMENDED SOIL. Instytut Uprawy, Nawozenia i Gleboznawstwa, Pulawy (Poland). Trace Element Lab.

S. Dudka, and A. Chlopecka. Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 1/2, p 153-160, May 1990. 8 tab, 16 ref.

Descriptors: \*Bioavailability, \*Land disposal, \*Path of pollutants, \*Sludge disposal, \*Soil amendments, \*Speciation, \*Trace metals, Adsorption, Agriculture, Leaching, Lysimeters, Plant physiology, Sequential extraction.

In land application of sewage sludge large amounts of trace metals may be introduced into the soil. In addition, contamination of groundwater with trace metals is likely to occur following massive sewage sludge application to the land. Sequential extraction was utilized for partitioning cadmium, chromium, nickel, and zinc, in soil and sludge samples, into five operationally-defined fractions: exchangeable, bound to carbonates, bound to iron-manganese oxides, bound to organic matter, and residuals. The highest amount of cadmium, nickel and nese Oxides, oound to organic matter, and residu-als. The highest amount of cadmium, nickel, and zinc, expressed as percent of the total, were found in the iron-manganese oxide fraction of the sewage sludge. Chromium was significantly associated with the organic fraction of the sludge. The resi-due was the most abundant fraction for all metals studied in the untreated soil, and for cadmium and nickel in the sludge-treated soil. The concentration of exchangeable cadmium and chromium was relaof exchangeable caulmini and chronium was rear-tively low in the untreated soil and did not change much after sludge application, whereas the concen-trations of exchangeable zinc increased about 50 times and the concentrations of exchangeable nickel doubled in the sludge-treated soil. A lysime-tric experiment revealed an increase in zinc and nickel uptake by ryegrass and in the percentage of metals leached from the soil profile after massive metals leached from the soil profile after massive sludge application. In contrast, only negligible changes were observed for cadmium and chromi-ium. The assumption that mobility and biological availability are related to metal speciation was confirmed by the agreement between the distribu-tion pattern of cadmium, chromium, nickel and zinc in the soils, the uptake of the metals by plants and their capacity for leaching out from the soils. (Author's abstract) W91-02089

GUIDELINES AND INTEGRATED MEASURES FOR PUBLIC HEALTH PROTECTION IN AG-RICULTURAL REUSE SYSTEMS.

World Health Organization, Geneva (Switzer-land). Div. of Environmental Health.

I. Hespanhol. Aqua AQUAAA, Vol. 39, No. 4, p 237-249, August 1990. 5 fig, 8 tab, 22 ref.

Descriptors: \*Public health, \*Wastewater disposal, \*Wastewater farming, \*Wastewater irrigation, \*Wastewater utilization, \*Water reuse, Agriculture, Coliforms, Epidemiology, Helminths, Pathogenic bacteria, Pathogens, Population exposure, Sanitary wastewater.

Wastewater recycling through agricultural schemes should be considered the preferred method of disposal and treated as an integral part of water resources planning. Based on a theoretical model predicting a descending order of risks of model predicting a descending order of risks of pathogen transmission by irrigation with raw wastewater, and on extensive epidemiological re-search done in the past 15 years, a new microbiolo-gical quality guideline in terms of concentration of intestinal nematodes and fecal coliforms is appropriate. The actual risk of irrigation with treated wastewater is much lower than previously estimated, and the early microbial standards and guidelines for effluent reuse were unjustifiably restriclines for effluent reuse were unjustinatory restric-tive, particularly with respect to bacterial patho-gens. Public health protection of the exposed groups can be attained through integrated meas-ures which include wastewater treatment, crop ures which include wastewater treatment, crop selection, appropriate wastewater application, and human exposure control. Appropriate technical and institutional measures to provide complete protection to both workers and consumers depends upon the availability of resources (institution, staff, funds), existing social and agricultural practices, and existing patterns of excreta-related diseases. Topics for additional research include wastewater walking assessment treatment technology applies. ality assessment, treatment technology, applica-

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tion technology, human exposure control, socio-cultural research and integration measures, epide-miological research, and aquaculture research. (Tappert-PTT) W91-02142

TRITIUM, OXYGEN-18, AND DEUTERIUM DIFFUSION AT THE CONFEDERATION ROAD LANDFILL SITE, SARNIA, ONTARIO,

University of Western Ontario. London. Faculty of Engineering Science.
For primary bibliographic entry see Field 5B.
W91-02146

HYDROGEOCHEMICAL PROCESSES CONTROLLING THE TRANSPORT OF DIS-SOLVED ORGANIC CARBON THROUGH A FORESTED HILLSLOPE. Oak Ridge National Lab., TN. Environmental Sci-

ences Div.

For primary bibliographic entry see Field 5B. W91-02159

ASSESSING DETOXIFICATION OF A COM-PLEX HAZARDOUS WASTE, USING THE MI-CROTOX BIOASSAY.

Utah State Univ., Logan. Div. of Environmental

Otah State Ontv., Logan. Ed. of State Engineering.
B. D. Symons, and R. C. Sims.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 4, p 497-505, July 1988. 8 fig. 4 tab, 19 ref.

Descriptors: \*Bioassay, \*Detoxification, \*Hazardous wastes, \*Industrial wastes, \*Microtox assay, \*Oil industry, \*Soil treatment, \*Toxicology, \*Waste treatment, Acute toxicity, Laboratory methods, Leaching, Loam, Microbiological studies, Oil, Petroleum products, Soil columns, Soil filters, Soil types, Waste management.

Research has demonstrated the usefulness of the Microtox bioassay in assessing the acute toxicity of organic compounds. Recently, the use of the Microtox bioassay has been extended to applications in hazardous waste management. The rapidity of the test, low sample requirements, and low cost provide several advantages over chemical analysis, especially for complex waste mixtures. Microtox especially for complex waste mixtures. Microtox bioassay results correlate closely with results from rainbow trout bioassays, and are more sensitive to inhibitory chemicals than activated sludge organisms. An experimental approach using batch reactors and soil columns was implemented in the laboratory to evaluate the detoxification and molaboratory to evaluate the detoxification and mo-bility of a toxic complex hazardous waste (a com-posite of three types of petroleum refinery wastes including American Petroleum Institute separator aludge, dissolved air flotation float, and slop oil emulsion solids) in soil. The objective of the study was to quantify the extent and rate of detoxifica-tion of a complex hazardous waste as affected by soil type and waste application rate. The extent and rate of detoxification was directly related to waste leading rate for both soil types (Kidman waste leading rate for both soil types (Kidman and rate of detoxincation was directly related to waste loading rate for both soil types (Kidman sandy loam and Nunn clay loam) investigated, in both batch reactors and soil column reactors. Anal-ysis of the toxicity of aqueous soil extracts at incremental depths through soil columns and of soil column leachate indicated a low leaching potential for the complex petroleum refinery waste. (Author's abstract) W91-02204

EFFECT OF SEWAGE SLUDGE ON NUTRI-ENT AND TOXIC METAL CONTENT OF SOIL AND SELECTED CROPS GROWN ON TROPI-

Puerto Rico Univ., Mayaguez. Dept. of Agronomy and Soils.

For primary bibliographic entry see Field 5C. W91-02239

HAZARDOUS WASTE MINIMIZATION: SOURCE REDUCTION ALTERNATIVES IN THE AEROSPACE INDUSTRY. CH2M Hill, Milwaukee, WI.

For primary bibliographic entry see Field 5D. W91-02411

SITING CONSIDERATIONS FOR RESOURCE RECOVERY FACILITIES.

STV, Inc., Pottstown, PA. R. Zyma. Public Works PUWOAH, Public Works PUWOAH, Vol. 121, No. 10, p 84-86, 134, September 1990. 1 fig.

Descriptors: \*Administrative agencies, \*Resource recovery facilities, \*Site selection, \*Waste disposal, \*Waste recovery, Economic aspects, Environmental assessment, Environmental impact, Political aspects. Resources management.

pects, Resources management.

The siting of resource recovery facilities is a complicated and often time-consuming procedure. The process must withstand the significant and somewhat relentless scrutiny of the public, regulatory agencies, and other interested parties. Even upon completion of the siting process, the regulatory agency permitting process remains a major obstacle. There are many technical, financial, environmental, and political considerations in selecting resource recovery as the study area's solid waste disposal option. Selecting a site that has a reasonable chance of withstanding these pressures is the initial step toward a successful project. Steps for resource recovery site selection start with determining the siting objectives and the study area. After selecting sting criteria, how to utilize that criteria must be established. Regional screening will identify candidate areas which must be narrowed into a few preferred areas. Selected sites within those areas should be rated and ranked. Environmental assessments will be needed for the Invironmental assessments will be needed for the Inghest ranked sites. After a preferred site is selectihighest ranked sites. After a preferred site is selected, preliminary design and the process of gaining regulatory and public approval can begin. (Mertzregulatory PTT) W91-02421

DEGRADATION OF PESTICIDE WASTE TAKEN FROM A HIGHLY CONTAMINATED SOIL EVAPORATION PIT IN CALIFORNIA. California Univ., Davis. Dept. of Environmental

For primary bibliographic entry see Field 5G. W91-02443

TWENTY YEARS OF LAND APPLICATION RESEARCH.

Agricultural Research Service, Beltsville, MD. Soil-Microbial System Lab.

R. L. Chaney. Biocycle BCYCDK, Vol. 31, No. 9, p 54-59, Sepber 1990. 2 fig, 2 tab, 14 ref.

Descriptors: \*Heavy metals, \*Sludge utilization, Biological magnification, Cadmium, Food chains, Molybdenum, Municipal wastewater, Phytotoxicity, Selenium, Sludge, Soil-water-plant relationships. Toxicity.

Since around 1970, scientific research has been conducted to assess the benefits and risks of using municipal sewage sludge on cropland. One of the most important findings of sludge research is that certain sludges have a 'no observed adverse effect level'. Much work has shown that sludges can be beneficial. No observed adverse effect level sludges, however, have especially low risk. The adsorption of metals and organics by adsorption sites in sludges is the technical reason why equal amounts of metals or organics can be applied in no observed adverse effect effect sludges without effects, while additions of pure chemicals to soils can cause adverse effects. The 'Soil-Plant Barrier' concept considers the potential toxicity to the food cept considers the potential toxicity to the cept considers the potential toxicity to the food chain if trace elements are applied to soils. Some metals are so insoluble or so strongly adsorbed to soil or in plant roots that they are not translocated into edible plant parts. Other elements are taken up by plants from sludge treated soils to a level that they may reduce the yield or even kill crops. Because of this phytotoxicity, excessive plant uptake compared to levels tolerated by animals, is prevented, thus protecting the food chain. Exceptions to the Soil-Plant Barrier exist: livestock have

been injured by excessive selenium and molybde-num and humans have been injured by cadmium. Sludge utilization was first regulated in 1979. The EPA has developed 12 fundamental pathways for risk assessment. The highest possible exposure to sludge applied contaminants can be avoided by using subsurface injection equipment or mixing the sludge into the plow layer soil before the grazing crop is seeded. (Mertz-PTT) W91-02470

DIFFUSION AND DISPERSION IN COASTAL WATERS

California Inst. of Tech., Pasadena. Dept. of Environmental Engineering Science.
For primary bibliographic entry see Field 5B. W91-02521

ESTIMATION OF FLOW THROUGH AND OVER ARMORED SLOPES.

Nuclear Regulatory Commission, Washington, DC. Div. of Waste Management.
R. B. Codell, S. R. Abt, T. Johnson, and J. Ruff. Journal of Hydraulic Engineering (ASCE) JHENDS, Vol. 116, No. 10, p 1252-1269, October 1990. 10 fig, 3 tab, 10 ref, append.

Descriptors: \*Armored slopes, \*Flow resistance, \*Radioactive waste disposal, \*Rainfall-runoff relationships, \*Riprap, \*Slopes, \*Waste disposal, Bank protection, Crushed rock, Darcy-Weisbach equation, Embankments, Flow models, Flumes, Laboratory methods, Mine wastes, Porosity, Rainfall, Rainfall intensity, Water conveyance.

Hazardous and radioactive wastes created in urani-um mining and milling are often stabilized from erosion by placing a protective filter blanket and um mining and milling are often stabilized from erosion by placing a protective filter blanket and armor riprap layer over a thick earth cover. Models developed for the transient routing of intense rainfall on these small armored slopes depend on expressions for flow resistance below and above the surface of the armored layer. A series of 52 experiments was conducted in two flumes to collect data on the basic relationships of flow resistance. Crushed rock of 26-155 mm median diameter was placed on embankments with slopes ranging from 0.01 to 0.2 and subjected to steady flow in the flumes. Flow through the rock layer was approximately proportional to the rock-layer prosity, the square root of the slope, and the mean diameter of the rock, and weakly proportional to the stage. The portion of flow through the filter layer generally cannot be neglected. Flow resistance decreased and conveyance greatly increased when the stage exceeded the depth of the rock layer. A model for flow but beneath and above the rock surface on an armored slope was synthesized from formulas developed for flow in rubble dams and Darcy-Weisbach formulas developed for flow in gravel bed streams and mountain rivers. The results of the model commare favorably to the experigravel bed streams and mountain rivers. The results of the model compare favorably to the experimental flow measurements. (Author's abstract) W91-02526

SAFETY AND EFFICACY OF FOOD PROCESSING SLUDGES AS ANIMAL FEED: CHEMICAL CHARACTERIZATION. T. E. Clevenger.

Research Journal of the Water Pollution Control Federation JWFFA5, Vol. 62, No. 6, p 820-827, September/October 1990. 7 fig, 10 tab, 19 ref. USDA Grant 85-CRSR-2-2548.

Descriptors: \*Animal feed, \*Food processing in-dustry, \*Industrial wastes, \*Pollutant identifica-tion, \*Priority pollutants, \*Sludge analysis, Food-processing wastes, Metals, Pathogens, Pesticides, Sludge disposal, Sludge utilization.

A tong-term, comprehensive study was conducted to determine the safety and efficacy of food processing sludges when used as an animal feed supplement. Sixteen different food processing plants were sampled and their sludges analyzed for 144 different compounds and elements, including those on EPA's list of priority pollutants. All sludges were found to have high protein and nutritive value while having low priority pollutant concentrations.

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None of the recommended limits for minerals in animal diets would be exceeded when fed at the recommended 10% level. The variability in sludge recommended 10% level. In evariability in studge composition over time was studied at one plant for two years and found to be low (less than 30%). Even though there exists a variability in the major and trace elements between the different types of and trace elements between the different types of food processing industries and each will have to be evaluated separately, all of the facilities using bio-logical treatment have one thing in common; the biomass (sludge) produced has a high nutritive value while being low in priority pollutants. Food processing sludges need can be excellent sources of animal feed and need to be better used. (Author's abstract)

ENERGY-EFFICIENT MUNICIPAL SLUDGE

ENERGY-EFFICIENT MUNICIPAL SLUIDGE INCINERATION.
Camp, Dresser and McKee, Inc., Cambridge, MA. M. J. Walsh, A. B. Pincince, and W. R. Niessen.
Water Environment & Technology WAETEJ, Vol. 2, No. 10, p 36-43, October 1990. 3 fig, 3 tab.

Descriptors: \*Energy costs, \*Incineration, \*Municipal wastes, \*Sludge disposal, \*Waste management, \*Wastewater treatment, Performance evaluation,

Sludge handling and disposal have become major Studge nanding and disposal have become major operational concerns at many wastewater treatment facilities. Today there is renewed interest in sludge incineration. There is an increased need for residuals volume reduction, and technical improvements have occurred in the fields of energy ments have occurred in the fields of energy recov-ery, sludge thickening and dewatering and emis-sions control. A study was performed to evaluate the status of sludge incineration with low fuel use. Three of the facilities selected for the study used Inter of the facilities selected for the study used multiple-hearth technology and one facility used fluidized-bed technology. Raw data were obtained through a review of available plant records and discussions with each plant's staff. Both energy discussions with each plant's siaff. Both energy input and output were estimated for each unit process, and energy efficiency was examined on several levels. For a fuel efficient sludge incineration facility, the study found that annual auxiliary fuel consumption within the furnace should be in the range of 1.2 to 1.4 mil kJ/dry tonne (1.0 to 1.2 mil Btu/dry ton) of sludge cake processed. Total annual costs for the incineration system after dewatering should be in the range of \$180 to \$225/dry tonne (\$163 to \$204/dry ton) of sludge cake processed when operating at capacity. The design, operation, and managerial features that strongly contribute to energy-efficient sludge incineration intribute to energy-efficient sludge incineration in-clude: a uniform furnace feed rate and quality; staff training and motivation, and cooperation be employees; a strong equipment maintenance program; a common staff goal of energy efficient furnace operation; and installation of a common operating philosophy and guidelines for the entire staff. (VerNooy-PTT) W91-02563

GUIDELINES FOR PHYSICAL AND BIOLOGI-CAL MONITORING OF AQUATIC DREDGED MATERIAL DISPOSAL SITES.

Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab. For primary bibliographic entry see Field 5A. W91-02607

EVALUATION OF LOADING AND DREDGED MATERIAL OVERFLOW FROM MECHANICALLY FILLED HOPPER BARGES IN MOBILE BAY, ALABAMA.

Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.

M. R. Palermo, and P. A. Zappi.

Available from the National Technical Information Service, Springfield, VA 22161. Miscellaneous Paper EL-90-16, September 1990. 21 p, 14 fig, 2 tab, 5 ref.

Descriptors: \*Dredging wastes, \*Mobile Bay, \*Overflow, \*Waste disposal, Alabama, Dredging, Field tests, Slurries, Solids.

Authorizing legislation for the deepening of navi-gation channels in Mobile Bay specifies that the

new work dredged material and material from future maintenance dredging must be placed in an approved open-water disposal site in the Gulf of Mexico. Large mechanical dredges with clamshell buckets are being used for the new work dredging. Hopper barges are loaded with the dredged material and transported by tug to the disposal site Mechanical dredging is also the most likely tech rial and transported by tug to the disposal site. Mechanical dredging is also the most likely technique for future maintenance. The economic loading of the hopper barges and the potential environmental impact associated with barge overflow during loading are important issues. Therefore, a field study was conducted to give site-specific information on the loading gains achieved by overflow, and the characteristics of the overflow for conditions in the Mobile Bay. The field study included: data collection on dredge-operating characteristics; sampling and testing of material comprising the barge overflow; and monitoring the loading characteristics of the barges. The dredge CHICAGO (equipped with a 30 cu yd clamshell bucket) and 600 cu yd hopper barges were used during the study. Loads gained during three overflow tests were 4.1, 1.2, and 11.5% for overflow periods of 60, 24, and 65 minutes. For all three overflow tests, the overflow ended with a significant amount of diluted slurry ponded in the barges, indicating that additional load gains would be possible with prolonged periods of overflow, and averaged 1,080 g/L, while the overflow was essentially constant for the entire period of overflow, and averaged 80 g/L. Results indicate that retention of solids in the hopper barges occurs during the overflow process for mechanical dredging. (Author's abstract)

ASSESSMENT OF OCEAN WASTE DISPOSAL.
TASK 5. HUMAN HEALTH IMPACTS OF
WASTE CONSTITUENTS. II. PATHOGENS
AND ANTIBIOTIC-AND HEAVY METAL-RE-SISTANT BACTERIA.
Maryland Univ., College Park. Dept. of Microbi-

ology. D. J. Grin

D. J. Offines. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-153084. Price codes: A08 in paper copy, A01 in microfiche. May 1986. 132 p, 11 fig. 27 tab, 283 ref.

Descriptors: \*Human diseases, \*Ocean dumping, \*Public health, \*Waste disposal, \*Wastewater pollution, \*Waster pollution effects, Coastal waters, Estuaries, Pathogenic bacteria, Waste management, Water pollution control.

The disposal of wastes in the ocean has been practiced by coastal nations for decades. All areas of the ocean have been subject to disposal use, including estuaries, nearshore, open shelf, and deep ocean sites. Until recently it was believed that pathogenic bacteria did not survive for any signifi-cant period of time in estuarine and marine envi-ronments. This document provides a description of: potentially harmful constituents of wastes (viruses, pathogenic bacteria, pathogenic fungi, pathogenic algae, protozoa, and helminths); ways in which these constituents could reach humans; known incidents of human disease contracted from wastes; detection of waste-borne disease agents; management technologies (facultative lagoon systems, activated sludge treatment systems, trickling-filter treatment systems, and disinfection); and monitoring and predictive trends. (Lantz-PTT) W91-02616

SEWAGE SLUDGE: APPLICATION TO SOILS (JAN 85 - JUL 89). CITATIONS FROM THE BIOBUSINESS DATABASE. Davis (J.J.) Associates, Inc., McLean, VA. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-866495. Price codes: NOI in paper copy, NOI in microfiche. August 1989. 83p.

Descriptors: \*Bibliographies, \*Fertilizers, \*Heavy metals, \*Sludge disposal, \*Sludge utilization, \*Soil amendments, \*Wastewater treatment, Regulations, Sludge analysis, Sludge treatment, Waste treat-

This bibliography contains citations concerning the application of sewage sludge to soil for agricultural or ameliorative purposes. Distribution of heavy metals from sewage sludge in amended soils and in plants grown in these soils is discussed. The fertilizing effect of sewage sludges and methods of processing, application, and analysis are included. Some regulatory questions and marketing scenarios for sludge fertilizers are presented. Sewage treatment is discussed in separate bibliographies. This new bibliography contains 168 citations fully indexed with a title list. (Author's abstract) W91-02643

SUMMARY OF RISK ASSESSMENT METH-ODOLOGIES FOR MUNICIPAL SLUDGE REUSE OR DISPOSAL OPTIONS.

Environmental Protection Agency, Cincinnati, OH. Office of Research and Development. R. J. F. Bruins, L. Fradkin, and J. F. Stara. Available from the National Technical Information

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-218168. Price codes: AO2 in paper copy, AO1 in microfiche. Report No. EPA/600/D-89/016. 1989. 7p,

Descriptors: \*Path of pollutants, \*Risk assessment, \*Sludge disposal, Air pollution, Food chains, Groundwater pollution, Landfills, Leachates, Man-agement practices, Municipal wastewater, Ocean disposal.

Risk assessment methods have been developed which can be used to calculate criteria for controlling toxic pollutants in municipal wastewater studges. These methods consist of algorithms, ranging from simple to complex, which allow calculation of exposure and risk from various studge disposal practices. These calculations may show a usposa practices. These causatoris may show a need for management practice controls or for nu-merical limits on specific pollutants. Criteria for land-applied or distributed and marketed sludge may take the form of application rate limits (kg/ may take the form of application rate limits (kg) hay or concentration limits, calculated to control pollutant levels in the food chain or off-site movement in air or water. Criteria for landfilled sludge are defined in terms of acceptable leachate concentrations, as determined by an appropriate leachate characterization test, to prevent excessive groundwater contamination of vapor emission. Incineration criteria are expressed as limitations on stack emission rates (g/sec), based on predicted air concentrations at ground level. Criteria for sludgeemission rates (g/sec), based on predicted air con-centrations at ground level. Criteria for sludge which is ocean-disposed at the 106-Mile Site are calculated in terms of sludge concentration and total daily pollutant input to the site, in order to protect marine life and human consumers of sea-food. These risk assessment methods were devel-oped in a research environment in order to pro-mote scientific consistency in the regulatory promote scientific consistency in the regulatory process. (Author's abstract) W91-02666

HAZARDOUS WASTE CONTAINMENT USING CLAY LINERS

Wayne State Univ., Detroit, MI. Dept. of Civil Engineering.
C. J. Miller, and M. Mishra.
Manage

C. J. Miller, and M. MISITA.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 191-199, 4 fig, 12 ref.

Descriptors: \*Clay liners, \*Groundwater pollution, \*Groundwater quality, \*Hazardous waste disposal, \*Landfills, \*Leaching, \*Path of pollutants, \*Water pollution control, \*Water quality management, Darcys law, Drying, Flow models, Groundwater management, Landfill liners, Leakage, Mathematical analysis, Model studies, Open-channel flow, Porosity, Vertical flow, Water resources manage-

The use of clay liners is prevalent in the waste disposal industry. The liner is expected to perform a most critical function. It provides a barrier between the natural environment and the deposited waste. It is obvious that unrestricted migration of the waste could lead to soil, groundwater, and

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surface water contamination. However, it has also become evident that such environmental problems are also prevalent in the vicinity of landfills constructed with clay and/or synthetic liner barriers.

Current models have been shown to underestimate the actual leakage volumes because of the existence of macropores, especially attributed to desiccation cracking. A conceptual model of flow through cover liners has been developed that acknowledges cover liners has been developed that acknowledges the existence of macropores. Flow through the clay matrix is modeled using Darcy's law, while the macropore flow component is modeled using the equations governing analogous processes in open channel and closed conduit hydraulics. These equations are well developed and verified in other applications. Future investigations will provide the complete mathematical model of flow through clay liners incorporating the macropore concepts. Collection of field data for verification of the model is underway. (See also W91-02672) (Fish-PTT) PTT W91-02690

HYDROLOGIC HYDROCHEMICAL CHARAC-TERIZATION OF TEXAS FRIO FORMATION USED FOR DEEP-WELL INJECTION OF CHEMICAL WASTES.

Univ., Austin. Bureau of Economic Geolo-

gy. For primary bibliographic entry see Field 5B. W91-02814

MECHANISM OF ENRICHMENT OF TRACE METALS ON FINE SLUDGES COLLECTED FROM FILTRATION PLANTS.

FROM FILTRATION PLANTS. Kansei Kogyo K.K., Sakata (Japan). Inst. for Envi-ronmental Measurement. For primary bibliographic entry see Field 5A. W91-02819

EC BATHING WATERS DIRECTIVE AS AP-PLIED TO SCOTLAND.

Forth River Purification Board, Edinburgh (Scot-For primary bibliographic entry see Field 5G. W91-02848

SLUDGE DISPOSAL STRATEGY FOR DUM-FRIES AND GALLOWAY REGIONAL COUN-CIL.

J. N. Dobsor

Journal of the Institution of Water and Environ-mental Management JIWMEZ, Vol. 4, No. 4, p 371-378, August 1990. 3 fig, 9 tab, 7 ref.

Descriptors: \*Land disposal, \*Legislation, \*Scotland, \*Sludge disposal, \*Waste disposal, Agriculture, Dumfries, Galloway, Odor control, Regulations, Septic tanks, Sludge lagoons, Sludge treat-

The Dumfries and Galloway Regional Council's largely rural statutory area extends to 6370 sq km, with a population of 146,000. During 1988, the Council, mindful of impending legislation likely to affect existing sludge disposal outlets, particularly those in agricultural land, commissioned a detailed study into all aspects of sewage sludge production, treatment, storage and disposal. The aim of the study was the production of a regional sludge disposal strategy. Consideration was given to five different options of sludge disposals. The following recommendations were outlined: (1) disposal of sewage sludge to agricultural land; (2) the Regional Council to carry out spreading operations; (3) retain lagoons as emergency reserves stearchs. The Dumfries and Galloway Regional Council's sewage sludge to agricultural land; (2) the Regional Council to carry out spreading operations; (3) retain lagoons as emergency reservoir storage; (4) construction of four sludge treatment centers, incorporating mesophilic anaerobic digestion and fine screening; (5) install an odor control plant; (6) operate a microcomputerized sludge maintenance control system; (7) appoint a sludge management officer; (8) purchase and operate farms; (9) utilize the expertise of the Barony College of Agriculture; (10) commission a study to identify an optimum working plan for sludge tanking operations; (11) rationalize the sizes of community septic tanks; (12) improve sludge thickening at larger works; (13) develop a program for emptying community and private septic tanks; (14) intensify trade effluent

monitoring; and (15) terminate centrifuge dewater-ing and thermophilic aerobic digestion of sludge at Annan. (Lantz-PTT) Annan. (La W91-02850

EUROPEAN ENVIRONMENTAL DIRECTIVES-IMPLICATIONS FOR NORTHERN IRELAND.

For primary bibliographic entry see Field 5G. W91-02851

GAS MIGRATION IN DISCRETE FRACTURE

NETWORKS.

Royal Inst. of Tech., Stockholm (Sweden). Dept. of Land and Water Resources.

R. Thunvik, and C. Braester.

Water Resources Research WRERAQ, Vol. 26, No. 10, p 2425-2434, October 1990. 6 fig. 3 tab, 7 october 1990.

Descriptors: \*Fracture permeability, \*Gas migra-tion, \*Geologic fractures, \*Path of pollutants, \*Ra-dioactive waste disposal, \*Underground waste dis-posal, Boundary conditions, Flow rates, Mathe-matical models, Permeability, Pressure distribution.

A mathematical model is presented for the upward pulsating gas-water displacement, from a gas source at a constant production rate or pressure at source at a constain production fact or pressure as the bottom boundary to a constant pressure boundary at the top boundary. The study shows a complicated flow phenomenon caused by the unequal advance of the gas in fractures of different permeability or different inclinations. The results show that the gas breakthrough at the surface is governed by the high permeability factor. At a constant rate of gas production the breakthrough is associated with a gas pressure build up and reinitates the upward displacement. Calculations with average properties of the fracture permeability, using the continuum approach, will underestimate the breakthrough time of the gas at the surface. Under the constant pressure boundary conditions at the top of the cavern the average permeability will overestimate the amount of gas carried out by the fracture network. Under constant flow rate boundary conditions at the top of the cavern, the bottom boundary to a constant pressure boundboundary conditions at the top of the cavern, calculations with average fracture permeability will overestimate the pressure in the cavern. The problem is of practical interest for low-level radioactive waste repositories located in hard rock below the sea bottom. (Author's abstract) W91-02871

#### DIVERSION CAPACITY OF CAPILLARY BAR-RIERS.

Disposal Safety, Inc., Washington, DC. B. Ross.

Water Resources Research WRERAQ, Vol. 26, No. 10, p 2625-2629, October 1990, 2 fig. 7 ref.

Descriptors: \*Capillary water, \*Groundwater barriers, \*Toxic wastes, \*Waste disposal, \*Water pollution control, Diversion structures, Hydraulic conductivity, Infiltration, Percolation, Permeability, Pressure potential, Soil porosity, Soil properties Soil extraction. s. Soil saturation. Waste management.

An important objective in the management of toxic wastes is to minimize the amount of water percolating through the wastes. An arrangement of unsaturated fine-grained soil overlying unsaturated coarse-grained soil along a sloping contact can, under appropriate circumstances, divert infiltrating water away from the coarser material. Such an arrangement is called a capillary barrier. The water is diverted by a capillary barrier flows downdip above the contact. The volume of water moving laterally increases in the downdip direction as additional infiltration is diverted by the barrier. Sufficiently far downdip, the laterally moving water wets the contact to the point that an amount of water equal to the infiltration flows downward through the coarse soil. The lateral flow at such a point represents the diversion capac-An important objective in the management of toxic downward inrough the coarse soil. The lateral flow at such a point represents the diversion capacity of the capillary barrier because this flow will not increase farther downdip. If the width (measured in the direction of dip) of the system is large enough that total infiltration exceeds the diversion capacity, the downdip portion of the barrier will

not be effective. The diversion capacity can be calculated exactly in the quasi-linear approxima-tion where the relationship between relative permeability (k-rel) and pressure potential (psi) takes the form k-rel = e to the alpha psi power. This the form K-fe! = e to the alpha psi power. Inis calculation shows that an upper bound on the width of capillary barriers is K-s tan phi/(q x alpha), where K-s is the saturated hydraulic conductivity of the fine soil, phi is the dip angle of the contact, and q is the infiltration rate. (Author's W91-02887

LABORATORY INVESTIGATION OF BEACH PROFILES IN TAILINGS DISPOSAL.

Alberta Univ., Edmonton. Dept of Chemical Engi-

neering. X. Fan, and J. Masliyah. Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 11, p 1357-1373, Novem-ber 1990. 12 fig, 23 ref.

Descriptors: \*Beach profiles, \*Hydraulic mining, \*Mine wastes, \*Waste disposal, \*Waste management, Differential equations, Flumes, Mathematical models, Mining engineering, Sedimentation, Settleable solids, Slope stability, Slurries, Solid wastes.

Large quantities of tailings are produced daily in mining processes. Proper tailings disposal and man-agement of tailings ponds are required for environ-mental and economical reasons. Hydraulic methmental and economical reasons. Hydraulic methods, in which tailings and water are mixed to form a slurry, are often employed to transport tailings from the producing plant to the disposal site. When the slurry is discharged into the tailings pond, the coarse solids settle out, forming a beach, point, the coarse soluts settle out, forming a oeach, while the fine solids and water end up in the tailings pond as sludge, which has to be stored permanently. The management of hydraulically-deposited tailings is an important component of a unining operation, and involves prediction of the beach profile formed by the coarse solids. Transient beach profiles in tailings disposal were investigated both experimentally and theoretically. The tigated both experimentally and theoretically. In effects of feed solids concentration and total slurry discharge on beach profiles were examined using a plexiglass flume. It was found that the slope of the beach and the rising rate of the beach at the solids feeding point were much influenced by feed solids concentration. On the other hand, when the feed solids concentration is constant and the total slurry discharge inspired the beach of the beach do not read to the contract of the second of the sec solids concentration is constant and the total sturry discharge is varied, the slope of the beach does not change significantly. A nonlinear mathematical model is developed to predict beach profiles. The resulting partial differential equation is solved numerically by a simple explicit scheme. Very good agreement between the experimental data and the agreement between the experimental data and the theoretical prediction is observed. The experimental data and the experime tal data are also correlated successfully with a power expression, which is often seen in mining engineering literature. (Author's abstract) W91-02919

ABSENCE OF CADMIUM IN THE BLOOD OF HORSES FED OATS GROWN ON MUNICIPAL SLUDGE-AMENDED SOIL.

G. A. Maylin, C. A. Bache, and D. J. Lisk. Science of the Total Environment STENDL, Vol. 96, No. 3, p 313-316, August 1990. 2 tab, 10 ref.

Descriptors: \*Blood, \*Cadmium, \*Oats, \*Path of pollutants, \*Sludge disposal, \*Sludge utilization, \*Water pollution effects, Farms, Food chains, Industrial wastes, Municipal wastes, Toxicity.

Effluents from a number of industries which are typically treated in municipal sewage plants result in cadmium-containing sludge. Disposal of such sewage sludge by application to agricultural land can result in uptake of cadmium by crops. Oats were grown on soils which had been amended with sewage sludge from Syracuse, New York. The cadmium concentration in the sludge-grown oats was 1.79 ppm dry weight. Horses were fed the Effluents from a number of industries which are oats was 1.79 ppm dry weight. Horses were fed the sludge-grown oats for 6 weeks during which time sludge-grown oas for a weeks during which time blood samples were taken for the determination of cadmium. No significant differences were found in the concentration of cadmium in the blood of the horses consuming the oats compared with that in

#### Water Treatment and Quality Alteration-Group 5F

the blood before feeding began (control). The well-known efficient accumulation of renal cadmi-um by horses may account for a lack of significan-ly increased cadmium in blood during the feeding eriod. (Author's abstract)

IMPACT OF SYNTHETIC LEACHATE ON THE HYDRAULIC CONDUCTIVITY OF A SMECTITIC TILL UNDERLYING A LANDFILL SMECTHIC HIL UNDERLYING A LANDFILL NEAR SASKATOON, SASKATCHEWAN. National Hydrology Research Inst., Saskatoon (Saskatchewan). Ground Water Div. E. K. Yanful, M. D. Haug, and L. C. Wong. Canadian Geotechnical Journal GJOAH, Vol. 27, No. 4, p 507-519, August 1990. 14 fig, 6 tab, 41

Descriptors: \*Glacial drift, \*Hydraulic conductivity, \*Landfill linings, \*Leachates, \*Permeability, \*Smectitic till, Canada, Clay minerals.

An evaluation is presented on the effects of leachate on the hydraulic conductivity, k, of a smectitic glacial till used in the construction of a compacted earth liner for a landfill near the city of Saskatoon, Saskatchewan, Canada. Low gradient triaxial permeability testing of the water-molded till over a 7-month period with six pore volumes of test leachate at a hydraulic gradient of approximately 100 gave a hydraulic conductivity of 0.3 mm/s, compared with 0.6 mm/s for the water-permeated sample at the same gradient. The k was also evaluated at gradients of 20 and 50 during water permeation and found to be 0.8 and 0.68 ncm/s, respectively. The slight decrease in k with increase in gradient was attributed to a decrease in void ratio, resulting from a net increase in applied effective stress at the outflow end of the specimen. An assessment of the clay mineral composition of the till at the end of permeability testing did not show collapse of the smectite peak. It was concluded that the leachate did not have any detrimental latt, the leachate did not have any detrimental latt, the leachate did not have any detrimental latt. An evaluation is presented on the effects of leachappeared to have actually enhanced the smectite peak relative to the illite peak. It was concluded that the leachate did not have any detrimental impact on the till and that the hydraulic conductivity of the 0.3m thick liner underlying the landfill may not be expected to increase as a result of interaction with leachate. (Author's abstract) W91-02943

IMPACT OF DISTILLERY EFFLUENT APPLICATION TO LAND ON SOIL MICROFLORA.
National Environmental Engineering Research Inst., Nagpur (India). For primary bibliographic entry see Field 5C. W91-02946

REGIONAL SLUDGE MANAGEMENT PLAN-NING IN VERMONT. Dufresne-Henry, Inc., North Springfield, VT. M. E. Lang, T. D. Nesbitt, and R. A. Jager. Water Environment & Technology WAETEJ, Vol. 2, No. 9, p 15-18, September 1990.

Descriptors: \*Composting, \*Liquid sludge, \*Sludge cake, \*Sludge management, \*Sludge treat-ment, \*Vermont, Administrative regulations, Land disposal, Regional analysis, Regional planning,

Tougher state regulations on sludge management in Vermont compelled Environmental Conservation municipal officials in 1987 to study and evaluate options for regional sludge management. The options involved as many communities as possible and allowed those generating the least sludge to benefit from the economy of scale. This study resulted in two conclusions. First, land application of dewatered sludge cake (20% solids) represented a significant savings over land application of liquid sludge, because of the additional storage and transportation needs associated with land application of liquid sludge. Second, with the exception of the land application of liquid sludge and vertical plug flow composting, the present worth costs of the remaining alternatives are relatively close, ranging from \$8.9 million for contract land application of dewatered sludge to \$10.3 million for horizontal agitated bin composting. The analysis for the Rut-

land and Connecticut River Valley regions yielded similar results. Recommendations are given for the most cost-effective sludge management for each region studied. (Medina-PTT) W91-02954

SITING AND TECHNOLOGY POSE CHALLENGES FOR COMMUNITIES ENDING LENGES FOR COMMUNITIES OCEAN DISPOSAL OF SLUDGE, Black and Veatch, Inc., Cambridge, MA For primary bibliographic entry see Field 5D. W91-02955

#### 5F. Water Treatment and **Quality Alteration**

PROBLEMS OF GROUND WATER TREAT-MENT IN AN AREA OF DEPRESSION (ZUR PROBLEMATIK DER GRUNDWASSERAUF-BEREITUNG IN EINEM ABSENKUNGSGE-

Kreiskrankenhaus Treuenbrietzin (German D.R.). For primary bibliographic entry see Field 5B. W91-02060

MICROBIAL QUALITY OF THE WATER IN THE DISTRIBUTION SYSTEM OF FLOR-

Florence Univ. (Italy). Inst. of Hygiene. L. Gambassini, C. Sacco, E. Lanciotti, D. Burrini, and O. Griffini.

Aqua AQUAAA, Vol. 39, No. 4, p 258-264, August 1990. 1 fig, 3 tab, 27 ref.

Descriptors: \*Florence, \*Italy, \*Pathogenic bacteria, \*Pathogens, \*Water distribution, \*Water quality, \*Water treatment, Bacteria, Pollutant identification, Potable water, Staphylococcus, Surface water, Water conveyance, Water quality monitoring, Water sampling, Water supply.

A significant tract of the water distribution net-work of the Florence waterworks, which purifies surface water from the Arno River, was monitored surface water from the Arno River, was monitored between March 1987 and February 1988. Physiochemical and microbiological parameters were analyzed in 66 samples of water. Samples were collected at 3-4 week intervals at six different points along the water distribution network. The network sampling points selected were used in an effort to establish the real residence time of water in the system. It was found that bacterial growth values were constant with the exception of a point error to establish the real residence time of water in the system. It was found that bacterial growth values were constant with the exception of a point at the end of the network, which experienced a lowering of chlorine and temperature variation. The most commonly isolated bacteria belonged to the families Pseudomonadaceae, Bacillaceae, Micrococcaceae, and Enterobacteriaceae as found by other authors. Stabhylococcus hominis, S. warneri, Pseudomonas maltophila, and Bacillas spp. were commonly found in the network. Opportunistic pathogens such as S. aureus and P. aeruginosa occurred only once in particularly favorable conditions at the terminal point of the network. The adoption of water filtration through granular activated carbon, which is in process in the treatment plant for the surface Arno River water, will further improve the quality of distributed drinking water by reducing the biodegradable organic carbon levels and limiting the growth of microorganisms. (Author's abstract)

EFFECT OF CHARGE DENSITY AND MOLEC-ULAR MASS OF CATIONIC POLYMERS ON FLOCCULATION KINETICS IN AQUEOUS

SOLUTION.
University Coll., London (England). Dept. of Civil Engineering.
J. Gregory, and S. Y. Lee.
Aqua AQUAAA, Vol. 39, No. 4, p 265-274,
August 1990. 9 fig, 2 tab, 19 ref.

Descriptors: \*Chemical coagulation, \*Floccula-tion, \*Polymers, \*Suspension, \*Water treatment, Cations, Physicochemical properties, Reagents,

At present there is limited understanding of dy-namic aspects of polymer adsorption and floccula-tion, especially in agitated suspensions. Kinetic as-pects of polymer adsorption and flocculation in stirred suspensions of silica particles have been pects of polymer adsorption and flocculation in stirred suspensions of silica particles have been studied using cationic polymers of different charge density and molecular mass. Silica particles were dispersed in deionized water and fractionated by sedimentation to give particles mainly in the 1-3 micrometer range. The polymeric flocculants were all copolymers of acrylamide or dimethylaminoethyl acrylate (DMAEA). The molar proportion of DMAEA determines the charge density. An optical method using a photometric dispersion analyzer was used to monitor flocculation. The results show that the rate of polymer adsorption can be slow compared to particle collision rate, especially when the polymer is of low charge density and low molecular mass. The charge density of a polymer is important in determining the optimum dosage. For all of the polymers used, the amount of positive charge adsorbed at their respective optimum dosages is about the same. However, the rate of adsorption and the flocculation rate may be affected by charge density and molecular mass. (Tappert-PTT)

PRECONCENTRATION OF COPPER ON ALGAE AND DETERMINATION BY SLURRY GRAPHITE FURNACE ATOMIC ABSORPTION SPECTROMETRY.

Texas Univ. at Austin. Dept. of Chemistry and Biochemistry.

For primary bibliographic entry see Field 5A. W91-02191

COMPARISON OF QUARTER-HOURLY ON-LINE DYNAMIC HEADSPACE ANALYSIS TO PURGE-AND-TRAP ANALYSIS OF VARYING VOLATILE ORGANIC COMPOUNDS IN DRINKING WATER SOURCES.

Drexel Univ., Philadelphia, PA. Dept. of Chemis-

For primary bibliographic entry see Field 5A. W91-02219

IMPACT OF HANDPUMP CORROSION ON WATER QUALITY. International Bank for Reconstruction and Devel-opment, Abdidjan (Ivory Coast). Regional Water and Sanitation Group.

and Sanitation Group.

O. Langenegger.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 594-604, 7 fig, 1 tab, 2 ref.

Descriptors: \*Corrosion, \*Domestic water, \*Groundwater quality, \*Pumps, \*Wells, \*West Africa, Biofilms, Deterioration, Developing countries, Galvanized metal, Ghana, Iron, Ivory Coast, Pipes, Rural areas, Steel, Water mains.

The exploitation of groundwater by means of bore-holes for supplying small user groups and rural communities with water has been widely applied in various parts of the world for decades. In recent years this practice has become global, with hun-dreds of thousands of boreholes drilled to tap low-tering the property of the property of the pro-terior of the protection of the protection of the pro-terior of the protection of the protection of the protection of the pro-terior of the protection of t years tms practice has become global, with nun-dreds of thousands of boreholes drilled to tap low-yielding aquifers. In developing countries hand-pumps usually are used for lifting the water, al-though solar or other systems with submersible pumps also are used. The experience gained with handpump-equipped boreholes within the World Bank executed inter-regional UNDP-Handpumps Project (INT/81/026) provided quantitative data on the water quality of wells in terms of iron concentration and other parameters. The corrosive attack on galvanized iron, the effect of biofilms on the corrosion rate, and the difference between internal and external corrosion of rising mains are shown by these data. A biofilm developed on a mild steel specimen at 27 C within about 30 to 40 hr, whereas no biofilm, or only traces, was ob-served on the specimen at 10 C. The dissolution of iron through corrosion measured as iron increase

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(total Fe) was indirectly proportional to the forma-tion of the biofilm and the NH4 concentration at 27 C. The iron increase was higher and relatively constant at 10 C. Under prevailing conditions in the investigated areas (Ivory Coast and Ghana). galvanization does not protect mild steel from cor-rosion. Internal parts of rising main assemblies seemed to show a higher tendency to form protective biofilms compared to the external parts. The less a pump is operated, the more corrosion prod-ucts are formed and accumulated in the rising main assembly and in the well. (See also W91-02288)

PULSA SOLAR: SOLAR WATER OSCILLA-TION PUMPS FOR VILLAGE HYDRAULICS. Fluxinos Italia S.R.L., Grosseto. T. E. Manning, E. Mencarelli, and G. Cefis. IN: The State-of-the-Art of Hydrology and Hy-drogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouaga-dougou, Burkina Faso, 18-23 February 1989. Inter-national Water Resources Association, Urbana, Il-liancia 1909 pt. 712.721 linois. 1990. p 712-721.

Descriptors: \*Developing countries, \*Pumps, \*Rural areas, \*Solar energy, \*Water supply, Africa, Cost analysis, Design criteria, Drinking water, Economic aspects, Oscillation pumps, Pulsa Solar, Semiarid lands, Wells.

Solar, Semiarid lands, Wells.

A solar water oscillation pump (PULSA SOLAR) for village hydraulics in developing countries was developed that will supply 25 liters of water per person per day from boreholes with water depths 0.50 m. The pump is designed to provide the minimum water prescribed by the World Health Organization for villages of 200 people for drinking and personal use. Photovoltaic arrays of only 160-240 Wp are employed. Analysis of the cost effectiveness of the PULSA SOLAR pumps was conducted. Global maintenance costs for both PULSA pumps and PULSA SOLAR pumps over a long period can be limited to \$ 0.50 (US) per person per year. The additional investment cost of a PULSA SOLAR pump, if written off over a period of 10 yr, amounts to \$ 1.50 per person per year in a village of 200 persons. (See also W91-02288) (Rochester-PTT) W91-02347

DESIGN AND MANAGEMENT OF RURAL WATER SUPPLY PROJECTS: LESSONS LEARNED FROM COMPARATIVE STUDY OF USAID PROJECTS IN BURKINA FASO AND

Water and Sanitation for Health Project, Arling-P. Roark.

P. Roark.

In: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 902-910, 2 ref.

Descriptors: \*Benefits, \*Burkina Faso, \*Develop-Descriptors: "Benefits, "Burkina Faso, "Develop-ing countries, "Political aspects, "Public policy, "Rural areas, "Togo, "Water supply, Governmen-tal interrelations, Maintenance, Management plan-ning, Public health, Sanitation, Social aspects, Water resources development, Wells.

The design and management of rural water supply projects in many developing countries require the active participation of four institutional entities: government, local communities, private sector entrepreneurs, and international donors. A comparative study of two United States Agency for Inter-national Development (USAID)-funded projects in Burkina Faso and Togo provides interesting con-clusions on the roles that each of the entities can clusions on the roles that each of the entities can assume most efficiently. The projects were similar in that they installed more than 1700 wells in specific regions of the two countries and stressed community development and health education as a part of the total program. Their design and man-agement approaches were, however, different and led to different results and conclusions. The Bur-

kina Faso project was conducted separately from the national government; it had its own personnel (342) and vehicles, office, and other equipment. Most of the staff were temporary and their employment ended at the end of the project. In Togo, ployment ended at the end of the project. In Togo, existing social and technical agencies were involved and the well drilling itself was conducted by a private firm hired through a competitive bidding process. The advantage of the Togo project is that project sustainability and replicability are entrenched within a permanent Togo government institution that will continue in the future. ernment institution that will continue in the future.

Balanced development requires projects to coordinate the individual components of water, sanitation, health, education, and community participation. More emphasis is needed in the latter three tion. More emphasis is needed in the latter three components to maximize the health benefits of water supply. Operations and maintenance of water systems continues to be a problem that will require more attention by project designers and managers in the future. (See also W91-02288) (Rochester-PTT) W91-02362

KEY FACTORS IN TASTE AND ODOUR PROBLEMS FOR MUNICIPAL WATER WORKS USING SURFACE WATER SOURCES. Waterloo Univ. (Ontario). Dept. of Civil Engineer

ing. E. A. McBean. Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 881-891, 1990. 5 fig, 9 tab, 19 ref.

Descriptors: \*Algae, \*Aquatic bacteria, \*Eutrophication, \*Fungi, \*Limiting nutrients, \*Municipal water, \*Odors, \*Organoleptic properties, \*Phytoplankton, \*Taste, \*Water pollution sources, \*Water quality, \*Water treatment, Diatoms, Lake Huron, Nitrates, Phosphorus, Silicates, Silicon.

Taste and odor problems of municipal water supplies can be grouped into two main categories: those associated with algae and other organisms naturally found in surface water, and those associated with industrial and municipal waste inputs to surface waters. This study considers taste and odor problems of natural origin. Planktonic algae are of problems of natural origin. Planktonic algae are of importance in water supplies and water pollution, and fall into four classes: blue-green algae, green algae, diatoms, and pigmented flagellates. Fungi and bacteria associated with the decomposition of organic matter can also cause taste and odor problems. Primary environmental factors such as nutrient availability, sunlight and water temperature affect algal growth. Phosphorus is the most significant factor in blue-green algal blooms, while carbon and nitrogen are less likely to be limiting. Silicon, in the form of silicates, is essential to the caroon and integer are less likely to be illimited. Silicon, in the form of silicates, is essential to the growth of diatoms. Silicate depletion can limit diatom growth or cause a shift to other algae. A case study of five-year records at three locations from Lake Huron have indicated that: (1) the phytoplankton levels (primarily diatoms) are not of phytoplankton levels (primarily diatoms) are not of a level to create taste and odor problems; (2) when the total P levels are low, then P is limiting the growth of phytoplankton. When P concentrations increase, phytoplankton levels are not limited by P levels. In this situation, the phytoplankton intensi-ties are responsive to levels of total Kjeldah intro-gen, reactive silicate and nitrate. This finding is in agreement with other studies which indicate that with the high biomass of diatoms in the spring, with the high blomass of diatoms in the spring, silica concentration probably becomes a limiting factor in Lake Huron, leaving room for more eutrophic forms to develop later in the season. (Sand-PTT) W91-02394

RELATING EMPIRICAL WATER QUALITY DIAGRAMS AND PLANKTON-DYNAMICAL MODELS: THE SAMPLE METHODOLOGY APPLIED TO A DRINKING WATER STORAGE RESERVOIR.

Rijksinstituut voor de Volksgezondheid, Utrecht (Netherlands).

T. Aldenberg, and J. S. Peters.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 893-911, 1990. 5 fig, 9 tab, 20 ref, 4 append.

Descriptors: \*Drinking water, \*Model studies, \*Phytoplankton, \*Sensitivity analysis, \*Storage

reservoirs, \*Water quality, \*Zooplankton, Chloro-phyll, Irradiation, Limiting factors, Nutrients, Transparency, Water quality trends.

Relationships have been established between trends in empirical water quality diagrams and sensitivity of steady states of plankton-dynamical models to changes in input, such as nutrient load and irradiance. A model with two trophic levels is and instantice. A flower with two topins levels into thickly to show input sensitivity to water quality parameters like chlorophyll or transparency. Input responsiveness is carried over to the second trophic level instead. To illustrate the methodology, this ic level instead. To illustrate the methodology, this model is applied to data from a drinking water storage reservoir near Amsterdam. The approach can be put into a more general setting. The limiting factor concept can be defined rigorously through sensitivity analysis, which also seems the right framework for monitoring indirect effects in general. The SAMPLE acronym (Sensitivity-Added Models for the Prediction of Linkages in Ecosystems) stresses the fact that, in order to monitor these linkages indirect effects) sensitivity modules tems) stresses the fact that, in order to monitor these linkages (indirect effects), sensitivity modules could be a permanent and invaluable part of eco-logical models. The linkages in fact then become states themselves. (Author's abstract) W91-02395

#### WATER TREATMENT PROBLEMS.

V. Moravcova. Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 967-975, 1990. 6 tab, 5 ref.

Descriptors: \*Drinking water, \*Operating policies, \*Water quality management, \*Water supply, \*Water quality management, \*Water sur \*Water treatment, Algae, Coagulation, Czech vakia, Filtration, Performance evaluation, V

Biological evaluations of changes in the quality of raw water in several Czech and Moravian watersupply reservoirs were carried out during the period 1980-87. Present Czech standards require the total absence of organisms in the drinking water, but only a few waterworks can meet this water, but only a few waterworks can meet this requirement. However, at many waterworks water treatment could be improved. Correctable problems encountered in a survey of Czech watertreatment facilities include: (1) failure to choose the optimal water intake depth; (2) use of other than the optimal type and dose of coagulant; (3) omission of laboratory coagulation tests; (4) infrequent use of auxiliary organic flocculent; (5) non-optimal length of filter runs; (6) failure to exclude from the water system the first fraction of rolluted from the water system the first fraction of polluted water after washing of rapid sand filters; (7) frequent interruption of treatment processes for 8 or more hours per day; and (8) poor raw water quality due to the overgrowth of algae, even in treatment plants with good operating procedures. (Author's abstract) W91-02400

POTENTIAL FOR EXPERT SYSTEMS IN WATER UTILITY OPERATION AND MANAGEMENT.

Clarkson Univ., Potsdam, NY. Dept. of Civil and

Clarkson Univ., Potsdam, NY. Dept. of Civil and Environmental Engineering. A. G. Collins, S. J. Nix, T. K. Tsay, A. Gera, and M. A. Hopkins. Journal of the American Water Works Association JAWWA5, Vol. 82, No. 9, p 44-51, September 1990. 2 fig, 3 tab, 49 ref.

Descriptors: \*Computer programs, \*Expert systems, \*Metropolitan water management, \*Utilities, \*Water distribution, Computers, Water conveyance, Water management, Water resources management, Water supply, Water use efficiency, Water usities.

The water utility industry has been and is seeking ways to use computer technology to enhance operations and management. One of the more exciting technologies to emerge in the last decade is the technologies to emerge in the last decaue is the expert system. An expert system is designed to simulate the advice and knowledge that experts provide about a problem or domain. These is no lack of potential applications for expert systems within the water industry. Generic expert systems,

## WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

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however, are not a viable alternative for water utilities at this time. Expert systems can be applied to any decision-making process. The more time devoted to the development of the expert system, the more it will mimic the expert. Therefore, applying expert systems is site and situation-dependent. The major cost associated with an expert system is usually the labor needed for development and maintenance. Computer hardware and software should be carefully chosen with this in mind. As with any other technology, it is important to carefully assess its usefulness and effectiveness before considerable resources are committed and expended. The usefulness of expert systems to a particular utility can probably best be determined by that utility. (Mertz-PTT) ever, are not a viable alternative for water

SIMPLE MEMBRANE FILTER METHOD TO CONCENTRATE AND ENUMERATE MALE-SPECIFIC RNA COLIPHAGES.
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 5A.
W91-02416

PYROLYSIS-GC-MS FOR INVESTIGATING HIGH-MOLECULAR-WEIGHT THM PRECUR-SORS AND OTHER REFRACTORY ORGAN-

Centre de Recherche Lyonnaise des Eaux - Degre-

Centre de Recherche Lyonnaise des Eaux - Degremont, Le Peoq (France).

A. Bruchet, C. Rousseau, and J. Mallevialle.
Journal of the American Water Works Association
JAWWAS, Vol. 82, No. 9, p 66-74, September
1990. 14 fig, 7 tab, 27 ref.

Descriptors: \*Analytical techniques, \*Gas chromatography, \*Halogenated hydrocarbons, \*Humic substances, \*Mass spectrometry, \*Organic compounds, \*Pyrolysis, \*Water analysis, \*Water treatment, Chlorination, Dissolved organic carbon, Separation techniques, Trihalomethanes, Water quality.

Natural waters typically contain 2 to 10 mg/L dissolved organic carbon (DOC). A refractory, nonchromatographable fraction comprising 85 to 95 percent of the DOC is often improperly referred to as 'humic acids'. Considerable interest in the transformation of these refractory organics during treatment processes was sparked by the discovery that the chlorination of humic substances could yield toxic trihalomethanes (THMs). stances could yield toxic trinaiometrianes (1 HMs). Since 1985, a preseparation technique has been developed using pyrolysis/gas chromatography (GC)/mass spectrometry (MS). This method allows the preparation of apparent molecular weight fractions. Extensive use of pyrolysis/GC/MS to further characterize these fractions has yielded significant results concerning the varying nature of DOC and thus an understanding of many aspects of water treatment, such as the efficiency aspects of water treatment, such as the enticiency of coagulation processes, the wide variations in the THM formation potential between waters of different origins, the competitive effects in adsorption or oxidation processes, and the fouling problems in membrane processes. (Mertz-PTT)

COMPARISON OF THE ZINC SULFATE AND IMMUNOFLUORESCENCE TECHNIQUES FOR DETECTING GIARDIA AND CRYPTO-SPORIDIUM. American Water Works Service Co., Inc., Belle-

ville, IL. Belleville Lab.
For primary bibliographic entry see Field 5A.
W91-02419

ASSESSING DEFINED-SUBSTRATE TECH-NOLOGY FOR MEETING MONITORING RE-QUIREMENTS OF THE TOTAL COLIFORM RULE. Illinois State Environmental Protection Agency,

Springfield.
For primary bibliographic entry see Field 5A.
W91-02420

FROM ZERO TO 20 MGD IN TEN MONTHS.

Indianapolis Water Co., IN. G. S. Lyons.
Public Works PUWOAH, Vol. 121, No. 10, p 92-93, September 1990, 2 fig.

Descriptors: \*Project planning, \*Upgrading, \*Water conveyance, \*Water supply development, \*Water treatment facilities, Drought effects, Indiana, Pumps, Water distribution, Water pressure,

Wells.

The Indianapolis Water Company experienced low pressures and inadequate domestic and fire flow in seven sections of their service area during the drought of 1988. Problems due to treatment and transmission were experienced in the extremities of the system in four separate pressure districts. The company engineering department developed an eight-item improvement plan with an estimated cost of \$9 million, to be implemented within one year. Seven of the eight projects were completed by the summer on 1989, resulting in no complaints attributed to low pressure in the four previously troubled areas. In addition, work came in \$1 million under budget. The seven completed projects, which included constructing new well fields and adding and improving pump stations, provided 20 million gallons/day additional production and/or pumping capacity. Having a continuous and competent short, middle, and long-range system planning program and owning the land needder of plant construction significantly helped expediate implements to the contraction of intervents and the projects in advance of the actual need for plant construction significantly helped expediate implements. projects in advance of the actual need for plant construction significantly helped expediate implementation of improvements. Maintaining a competent engineering organization and obtaining the authorization to specify and order necessary equipment also kept the project moving at its rapid rate. Careful selection of local consulting engineering firms to spread the work and close monitoring of costs on a weekly basis allowed for continuous work flow within budget. Adding bonus/penalty inservice date clauses to contract documents not in-service date clauses to contract documents pro-vided incentives to complete projects on time. (Mertz-PTT) W91-02422

COMPUTER-CONTROLLED WELL FIELD

AND DISTRIBUTION SYSTEM.

Browne (Floyd) Associates Ltd., Marion, OH.
D. Merriman. lic Works PUWOAH, Vol. 121, No. 10, p 113-114, September 1990. 1 fig.

Descriptors: \*Automation, \*Computers, \*Process control, \*Pumping, \*Water distribution, \*Water supply, \*Well pumping, Economic aspects, Municipal water, North Carolina, Storage tanks, Water conveyance, Wells.

Controlling well pumps, storage tanks, and distribution system flow became more efficient and costeffective when existing controls were upgraded
with a computer in Atlantic Beach, North Carolina. Atlantic Beach is a small resort community on
the North Carolina coast with a year-round population of 2000. The summer population climbs
above 20,000 from May through September, with a
peak of 50,000 on July 4th weekend. This wide
population spread places unusual demands on the
water supply system. The water supply comes
from four wells, a fifth well is being added in 1990.
The main problem with the existing control system from four wells, a fifth well is being added in 1990. The main problem with the existing control system was that lead well selection was based on the ground storage tank reaching its full level of 17 feet. Each time it did, another well was selected to teet. Each time it did, another well was selected to be the lead well. However, this caused many short pump cycles in the off-season winter months. The lead well would pump for more than the recom-mended 12 hours, because lead well selection was mended 12 hours, because lead well selection was based on tank level, not time. Economics dictated using existing equipment where possible. The wells' telemetering system could be used. Also, the water plant's existing pump control system could remain in place and act as the computer's backup. The only new equipment required was the computer, an interface relay panel (built on-site by the consultant), and customized software. The new program monitors the ground storage tank level, keeping the level between the high set point of 17 ft and a low set point of 12 feet. The computer selects a lead well pump to run when the ground storage tank is below 16 feet. It will run this pump

for a total of 12 hours. The computer-based control system was operating in less than 8 weeks for under \$15,000. The system has been on-line for over a year and functioning well. (Mertz-PTT) W91-02427

LEIGH CREEK TOWN WATER SUPPLY-A HISTORY.

R. E. Reed. Mines and Energy Review South Australia, No. 157, p 18-21, 1990. 3 fig, 7 ref.

Descriptors: \*Desalination, \*Leigh Creek, \*Pota-ble water, \*Water supply, \*Water supply develop-ment, Aroona Dam, Australia, Dams, Groundwater mining, Groundwater potential, Reverse osmo-sis, Saline groundwater, Salinity.

The township of Leigh Creek, 500 km north of Adelaide, Australia, was established progressively from 1941 to service the adjacent coalfields. Potable water was supplied initially from railway dams and natural catchments, but a more reliable source was required. The town was provided with water piped 48 km from Sliding Rock copper mine in 1944, but yields were low and the water was of 1944, but yields were low and the water was of poor quality. Aroona Dam was completed in 1954 to replace Sliding Rock, and this is still the main water source. By the mid-1970s, low water levels in Aroona Dam caused renewed interest in groundwater at Sliding Rock and areas closer to Leigh Creek. A drilling program was carried out in 1978, supplemented by further holes in 1981, and followed by a major program of 112 holes in 1982-83. Fifteen production wells resulted, with salinities ranging from 500 to 10,000 mg/L. These now supply up to 5.3 ML/day to a reverse osmosis desalination plant capable of producing 3.4 ML/day of potable water. (Author's abstract) W91-02528

TOTAL TRIHALOMETHANE FORMATION DURING TARGETED AND CONVENTIONAL CHLORINATION OF SEAWATER FOR BIOFOULING CONTROL.

N. M. Ram, Y. G. Mussalli, and W. Chow. Research Journal of the Water Pollution Control Federation JWPFA5, Vol. 62, No. 6, p 789-795, September/October 1990. 8 fig. 3 tab, 25 ref. EPRI

Descriptors: \*Biofouling, \*Chlorination, \*Trihalomethanes, \*Water pollution sources, \*Water treatment, Condensers, Effluents, Electric powerplants, Path of pollutants, Powerplants, Seawater, Water

Microbiological fouling of condenser tube surfaces is a major contributor to poor condenser performance, which in turn reduces power plant availability and reliability. Biofouling has been controlled in the past by the chlorination of cooling waters, a method subject to increasingly stringent regulatory control in response to environmental and health concerns. Utilities are attempting to use chlorine more efficiently by utilizing targeted chlorination, a technique involving the application of a relatively low dose chlorine solution (1.0 mg/L) for short periods of time (5 min) twice per day to selected fractional areas of the inlet tubesheet of the condenser. The potential for total trihalomethane fractional areas of the inlet tubesheet of the con-denser. The potential for total trihalomethane (TTHM) formation was compared using conven-tional versus targeted chlorination. Results indicat-ed that targeted chlorination significantly de-creased TTHM formation when compared to the conventional chlorination of cooling waters. Bro-moform was the predominant THM formed in all cases, owing to the oxidation of naturally occur-ring bromide in seawater when chlorinated, with subsequent conversion to bromoform when reacted with organic precursors. Introduction of additional subsequent conversion to ormotorian with reacted with organic precursors. Introduction of additional chlorine to all samples yielded considerable TTHMs after a 7-day incubation, highlighting the importance of limiting chlorine dosage in complying with discharge limitations. (MacKeen-PTT) W91-02538

TOXICOLOGICAL RISK/BENEFIT-ASPECTS OF DRINKING WATER CHLORINATION AND

#### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5F-Water Treatment and Quality Alteration

OF ALTERNATIVE DISINFECTION PROCE-

DURES.
Forschungsinstitut fuer Mikrobiologie und Hygiene, Bad Elster (German D.R.).
K. Strobel, and H. H. Dieter.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 23, No. 4, p 152-162, August 1990. 9 tab, 156 ref.

Descriptors: \*Chlorination, \*Disinfection, \*Drinking water, \*Toxicity, \*Water treatment, Byproducts, Carcinogens, Chlorinated hydrocarbons, Mutagens, Risk assessment, Water pollution sources, Water quality control.

Although drinking water chlorination represents one of the biggest successes in sanitation achieved in this century, an important disadvantage of the procedure is the formation of toxic and mutagenic or even carcinogenic chlorinated organic com-pounds. Such compounds can also be found after application of alternative disinfectants (chlorine di-oxide, ozone, stabilized hydrogen peroxide), but application of alternative disinfectants (chlorine di-oxide, ozone, stabilized hydrogen peroxide), but probably to a lesser extent. Chlorination remains the best method of disinfection at present because of its superior disinfection capacity and permanent protection of the distribution system. The reduc-tion of the amount of organic precursors can be achieved using appropriate technologies for the treatment of raw wastewater (filtration, floccula-tion aested exercises along and rapid filtration tion, aerated reservoirs, slow and rapid filtration, treatment with ozone and activated carbon) and by optimal protection of water reservoirs. In many cases, these techniques will eliminate the need for cases, these techniques will eliminate the need for chlorination. Testing for organic precursors of by-products from chemical disinfection in drinking water and establishing limits for carcinogenic/mu-tagenic substances in chemically disinfected water are recommended. In the long run, the protection of drinking water resources and the creation of water catchment areas seem to be the most effecwater calcinnent areas seem to be the most energy tive and economic ways to keep the pollution of drinking water by disinfection products at a mini-mum level. (Author's abstract) W91-02547

STRUCTURE OF AN ANHYDRIDE RELATED TO A MUTAGENIC COMPONENT OF DRINK-ING WATER, 3-CHLORO-4-DICHLORO-METHYL-5-HYDROXY-2/5H-PURANONE.
State Univ. of New York at Syracuse. Coll. of Environmental Science and Forestry.
For primary bibliographic entry see Field 5A. W91-02551

MODELING INACTIVATION OF GIARDIA LAMBLIA

Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab.

JOEDU, Vol. 116, No. 5, p 837-853, 1990. 3 fig. 12 tab. 21 ref.

Descriptors: \*Disinfection, \*Giardia, \*Mathemati-Descriptors: "Olartia, Matternatical equations, "Mathematical models, "Regula-tions, "Standards, "Water treatment, Bacteria, Chlorination, Chlorine, Hydrogen ion concentra-tion, Kinetics, Model studies, Surface Water Treatment Rule, Temperature, Viruses

Under the auspices of the Safe Drinking Water Act (SDWA) the US EPA has promulgated the Surface Water Treatment Rule (SWTR) requiring public water systems using surface water to provide minimum disinfection to control Giardia lamblia, enteric viruses, and bacteria. The C X to concept (concentration of disinfectant in mg/L times time in minutes) is used to establish the appropriate criteria for a surface system to achieve at least 99.9% inactivation of Giardia lamblia, and empirical equation was developed based on water temperature, pH, concentration of chiorine, and inactivation level, to predict required disinfection temperature, pH, concentration of chlorine, and inactivation level, to predict required disinfection criteria (C X t values). This paper describes the development of an equation, based on Chick-Watson kinetics, that provides equivalent informa-tion but is theoretically more consistent. The equa-tion can be used to predict C X t values for achieving 0.5 to 4 logs of inactivation, within temperature ranges of 0.5 to 5 C, chlorine concentra-tions up to 4 mg/L, and pH levels of 6 to 8. (Author's abstract) W91-02570

FILTRATION/ADSORPTION MEDIA BACTERIA AND TURBIDITY REMOVAL. Malnad Coll. of Engineering, Hassan (India). Dept.

of Civil Engineering.

S. Jayadev, and M. Chaudhuri.
Journal of Environmental Engineering (ASCE)
JOEEDU, Vol. 116, No. 5, p 998-1000, 1990. 3 fig.

Descriptors: \*Adsorption, \*Bacteria, \*Filtration, \*Turbidity, \*Water treatment, Alum, Developing countries, Domestic water, Escherichia coli, Vi-

In recent studies on the development of low cost filtration/adsorption media for the removal of bacteria and turbidity from water, alum-treated Giridih bituminous coal (alum-GBC) and ferric hydroxide-impregnated lignite (Fe-lignite) ranked highest among the coal/lignite-based media. However, a significant fraction of the sorbed bacteria ever, a significant fraction of the sorbed outcets remained viable and eluted in a desorption study. This technical note presents the results of Escheri-chia coli sorption/inactivation and sorption-de-sorption studies, and a down-flow column test to assess the usefulness of incorporating silver into alum-GBC and Fe-lignite in improving their performance. The results presented, together with the data on enteric (polio and rota) virus removal by alum-treated Giridih bituminous coal, suggest the potential usefulness of silver incorporated alumpotential iscriminess of since interpolarieal andi-treated bituminous coal as a medium for domestic water filtration in rural areas of developing coun-ries. Further work is underway to standardize the method of medium preparation and to test its performance using raw water (surface and ground) from different sources. (Lantz-PTT)

GUIDANCE DOCUMENT FOR PROVIDING ALTERNATIVE WATER SUPPLIES.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field 5G.

TECHNOLOGIES AND COSTS FOR THE TREATMENT OF MICROBIAL CONTAMINANTS IN POTABLE WATER SUPPLIES.

Pirnie (Malcolm), Inc., Paramus, NJ. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-175426.
Price codes: A15 in paper copy, A01 in microfiche.
October 1988. 315 p, 18 fig, 80 tab. EPA Contract

Descriptors: \*Costs, \*Drinking water, \*Potable water, \*Water treatment, Bacteria, Economic as-Pects, Giardia, Groundwater quality, Technology, Turbidity, Viruses, Water quality.

The best technologies taking costs into consideration, for inactivating or removing microbial con-taminants from surface water and groundwater supplies of drinking water were examined. For municipal officials, engineers and others, the document provides a review of alternative technologies and their relative efficiency and cost, and addresses water treatment technologies that may be used by community and non-community water systems in removing turbidity, Giardia, viruses, and bacteria from water supplies. The US EPA is developing treatment regulations addressing these microbial concerns. A brief discussion of disinfection techconcerns. A brief discussion of disinfection technologies and costs for groundwater supplies is also provided, since disinfection is the best available technology for groundwater systems to comply with coliform regulations. The information provided is intended to assist in reviewing available technologies for achieving the required reduction in turbidity and microorganisms. (Author's abstract) W01.00614 INVESTIGATION OF REST AREA REQUIRE-MENTS: APPENDIX-PERTINENT REST AREA LITERATURE.

Texas Univ. at Austin. Center for Transportation Research

For primary bibliographic entry see Field 5D. W91-02620

GUIDANCE MANUAL FOR COMPLIANCE WITH THE FILTRATION AND DISINFECTION REQUIREMENTS FOR PUBLIC WATER SYSTEMS USING SURFACE WATER SOURCES

Pirnie (Malcolm), Inc., Paramus, NJ. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-207047. Price codes: A16 in paper copy, A01 in microfiche. Draft Report, March 31, 1989. 361 p, 12 fig. 11 tab, 169 ref, 15 append. EPA Contract 68-01-6989.

Descriptors: \*Disinfection, \*Filtration, \*Manuals, \*Standards, \*Water quality, \*Water supply, \*Water treatment, Institutional constraints, Regulations, Surface water, Water supply develop

This draft Guidance Manual compliments the proposed filtration and disinfection treatment requireposed intration and disinfection treatment require-ments for public water systems using surface water sources (otherwise known as Surface Water Treat-ment Requirements (SWTR)). The purpose of this manual is to provide guidance to the EPA regional offices, individual States, and affected utilities in the implementation of the SWTR, and to help the implementation of the SWTR, and to help ensure that actions taken toward implementation are consistent. This manual is advisory in nature and is meant to supplement the criteria listed under the proposed SWTR. For example, the SWTR sets treatment requirements which encompass a large range of source water conditions. The guidance manual suggests design, operating and performance criteria for specific surface water quality conditions to provide the optimum protection of public health through multiple barrier treatment. These recommendations are presented as guidelines rather than an extension rule. They are offered to give the Primary Agency flexibility in establishing the most appropriate treatment retered to give the Frimary Agency Incoming in equirements for the waters within their jurisdiction. In order to facilitate the use of this manual, it has been structured to follow the framework of the proposed SWTR as closely as possible. (Author's abstract) W91-02623

DRINKING WATER QUALITY STANDARDS AND STANDARD TESTS (JAN 72 - MAY 89). CITATIONS FROM THE FOOD SCIENCE AND TECHNOLOGY ABSTRACTS DATABASE.

TECHNOLOGY ABSTRACTS DATABASE.
Davis (J.J.) Associates, Inc., McLean, VA.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB89-862809.
Price codes: NO1 in paper copy, NO1 in microfiche. June 1989, 112p.

Descriptors: \*Bibliographies, \*Drinking water, \*Water analysis, \*Water quality standards, \*Water treatment, Distribution systems, Testing procedures, Water distribution, Water sources.

This bibliography contains citations concerning standards and standard tests for water quality in drinking water sources, reservoirs, and distribution systems. Standards from domestic and international sources are presented. Glossaries and vocabularies that concern water quality analysis, testing, and evaluation are included. Standard test methods for individual elements, selected chemicals, sensory properties, radioactivity, and other chemical and physical properties are described. Discussions for proposed standards on new pollutant materials are briefly considered. (Contains 290 citations) (Author's abstract) sources are presented. Glossaries and vocabularies thor's abstract) W91-02646

HEAVY METALS IN DRINKING WATER: STANDARDS, SOURCES, AND EFFECTS (JAN 78 - SEP 89). CITATIONS FROM THE LIFE SCIENCES COLLECTION DATABASE Davis (J.J.) Associates, Inc., McLean, VA.

## WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

## Water Treatment and Quality Alteration-Group 5F

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-871339. Price codes: AO1 in paper copy, AO1 in micro-fiche. September 1989. 46p.

Descriptors: \*Bibliographies, \*Drinking water, \*Heavy metals, \*Public health, \*Toxicity, \*Water pollution effects, \*Water pollution sources, \*Water treatment, Acid rain, Corrosion, Groundwater pol-

This bibliography contains citations concerning the public health aspects and documented studies of heavy metal pollutants in drinking water. Topics include human exposure studies and the toxicological effects incurred by ingestion. Prolonged expo-sure and quantification factors and effects, federal and state regulations and standards, and laboratory animal studies are discussed. Sources from landfill animal studies are discussed. Sources from landfill contamination of groundwater, acid precipitation contributions to groundwater pollution, and corrosion by-products in residential plumbing and public water supply transport systems are examined. (This updated bibliography contains 100 citations, 10 of which are new entries to the previous edition.) (Author's abstract)
W91-02647

WASTEWATER TREATMENT: OZONATION PROCESSES AND EQUIPMENT (JAN 77-APR 90). CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATA-

National Technical Information Service, Spring-

For primary bibliographic entry see Field 5D. W91-02667

FINITE ELEMENT GROUNDWATER MODEL AS ESSENTIAL PLANNING TOOL: MICRO-BIOLOGICAL DENITRIFICATION OF A WELL FIELD AT BROICHHOF.

WELL FIELD AT BROICHHOF.
Lahmeyer International G.m.b.H., Frankfurt am
Main (Germany, F.R.).
H. Lutkestratkotter, and W. Pelka.
IN: Groundwater Management: Quantity and
Quality. Proceedings of the Symposium held at
Benidorm, Spain, October 2-9, 1989. International
Association of Hydrological Sciences, Washington, DC. 1989. p 359-368, 8 fig.

Descriptors: \*Denitrification, \*Finite element Descriptors: \*Denitrification, \*Finite element method, \*Germany, \*Groundwater management, \*Hydrologic models, \*Model studies, \*Nonpoint pollution sources, \*Water pollution sources, \*Water quality management, \*Water treatment, \*Well fields, Aerobic treatment, Drinking water, Field tests, Flow system, Graphical methods, Groundwater movement, Hydraulic properties, Rehabilitation, Water resources management.

Increased nitrate content in groundwater caused by mineral-based fertilizers calls for newly devel-oped denitrification measures and processes. To develop such processes, it is necessary to combine theoretical research, field tests, and engineering activities. A research project was undertaken in Germany on rehabilitation of aquifers by con-trolled denitrification and final underground aerotrolled denitrification and inna underground aero-bic treatment. The aim of the project was to deter-mine all relevant operational parameters for large scale application in waterworks. Groundwater flow and hydraulic parameters were tested in some detail. Research in the aquifer meant a number of impacts on both the hydraulic and quality condiimpacts on both the hydraulic and quality condi-tions of the aquifer. A finite element model with linear triangular elements was applied. The flow regime was analyzed under the assumption of vari-ous boundary conditions and used as a basis to design and to optimize test wells and infiltration galleries. During model calibration a high degree of accuracy was reached resulting in only very small deviations between simulated and historically observed water table values for all cases compared. To facilitate the interpretation and comparison of results from the various simulations, the model directly produces graphic output comprising inter alia contour lines and flow vectors. It is planned to extend the model to simulate the transport of con-stituents in addition to pure groundwater flow. It was found that the finite element model proved to

be a valuable tool, since field work in a multi-use aquifer had to be coordinated with regular water-works operation and other activities. (See also W91-02672) (Fish-PTT) W91-02703

MADRID MIOCENE AQUIFER AS A COMPONENT OF THE METROPOLITAN WATER SUPPLY SYSTEM.
MOPU, Madrid (Spain). Servicio Geologico.
For primary bibliographic entry see Field 4B.
W91-02718

ALLUVIAL AQUIFER OF THE GRAND GRA-VIER (RHONE VALLEY, FRANCE) MODEL-LING AND PROTECTION.

Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Lyon For primary bibliographic entry see Field 5G. W91-02721

COST SUPPLEMENT TO TECHNOLOGIES AND COSTS FOR THE REMOVAL OF MERCURY FROM POTABLE WATER SUPPLIES. Environmental Protection Agency, Washington, DC. Criteria and Standards Div. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-192538. Price codes: A06 in paper copy, A01 in microfiche. January 1987. 109p, 7 fig, 24 tab, 3 append.

Descriptors: \*Costs, \*Economic aspects, \*Heavy metals, \*Mercury, \*Potable water, \*Water treatment, Activated carbon, Coagulation, Cost-benefit analysis, Filtration, Granular activated carbon, Lime, Reverse osmosis, Surface water, Water qual-

The cost estimates are a supplement to the cost section which appears in the December 30, 1984, report entitled, 'Technologies and Costs for the Removal of Mercury from Potable Water Supplies'. Because mercury is not commonly found in groundwaters, capital and operating costs for mercury removal technologies were only developed for surface water supplies. Cost estimates for the identified technologies have been developed based on information concerning waste disposal, capital costs and plant size. Costs were not developed for technologies identified as having future potential because additional testing and full-scale evaluations are necessary to determine design criteria and costs. The technologies for which updated costs were developed are: (1) coagulation/filtration, modified with powdered activated carbon for total mercury removal; (2) lime softening, modified for mercury removal; (2) lime softening, modified for inorganic mercury removal; (3) granular activated carbon (GAC) for total mercury removal; (4) coagulation/filtration with activated carbon for total aguiation/nitration with activated caroon for total mercury removal (5) reverse osmosis for total mer-cury removal; (6) point-of-use treatment; (7) re-gionalization; and (8) alternate source. GAC was found to be the most economical treatment technology for new systems. (Lantz-PTT) W91-02725

COST SUPPLEMENT TO TECHNOLOGIES AND COSTS FOR THE REMOVAL OF NITRATES AND NITRITES FROM POTABLE WATER SUPPLIES.

WATER SUPPLIES.
Environmental Protection Agency, Washington,
DC. Criteria and Standards Div.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB89-192488.
Price codes: A05 in paper copy, A01 in microfiche.
First Draft. February 1987. 72p, 7 fig, 17 tab, 3

Descriptors: \*Costs, \*Economic aspects, \*Ground-water quality, \*Nitrates, \*Nitrites, \*Potable water, \*Water treatment, Chlorination, Cost-benefit anal-Ion exchange, Reverse osmosis, Water qual-

The cost estimates are a supplement to the cost section which appears in the September 30, 1985, report entitled, 'Technologies and Costs for the Removal of Nitrates and Nitrites from Potable

Water Supplies. Since nitrates and nitrites are generally found in groundwater supplies, capital and operating costs for all technologies were developed. Cost estimates for the technologies identified and were developed for the following technologies: (1) ion exchange; (2) breakpoint chlorination ogies: (1) ion exchange; (2) breakpoint chlorination intrites only); (3) reverse osmosis; (4) point-of-use; (5) modifying existing wall systems; (6) regionalization; and (7) alternate sources. The most economical method of treatment for systems with capacities between 0.01 and 0.3 million gallons per day (mgd) is to modify the existing well systems. For plant design capacities > 0.3 mgd, breakpoint chlorination is the most economical treatment technology for artificial seasons and modificial existing well systems is the most economical treatment technology for nitrites, and modifying existing well systems is the most economical for nitrates. (Lantz-PTT) W91-02726

COST SUPPLEMENT TO TECHNOLOGIES AND COSTS FOR THE REMOVAL OF CHROMIUM FROM POTABLE WATER SUPPLIES. Environmental Protection Agency, Washington, DC. Criteria and Standards Div.

DC. Criteria and Standards Div. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-192470. Price codes: A03 in paper copy, A01 in microfiche. First draft. February 1987. 131 p, 8 fig, 30 tab, 3

Descriptors: \*Chromium, \*Costs, \*Economic aspects, \*Potable water, \*Water treatment, Anion exchange, Coagulation, Cost-benefit analysis, Filtration, Heavy metals, Reverse osmosis, Water

The cost estimates are a supplement to the cost section which appears in the January 31, 1985, report entitled Technologies and Costs for the Removal of Chromium from Potable Water Supplies. Since chromium is generally found in surface water supplies, capital and operating costs for all technologies were developed. Cost estimates for the identified technologies were developed based on information concerning waste disposal, capital costs and plant size. Costs were not developed for technologies identified as having future potential because additional testing and full-scale evaluations were necessary to determine design criteria and because adoitional testing and full-scale evaluations were necessary to determine design criteria and costs. The technologies for which updated costs were developed include the following: (1) coagulation/filtration, modified for removal of chromium tion/filtration, modified for removal of chromium (VI); (2) coagulation/filtration, new for removal of total chromium; (3) anion exchange for removal of chromium (VI); (4) cation exchange for removal of chromium (III); (5) lime softening, modified for removal of chromium (III); (7) two-bed ion exchange for removal of total chromium; (8) reverse osmosis for removal of total chromium; (9) reverse osmosis for removal of total chromium; verse osmosis for removal of total chromium; (9) point-of-use; (10) regionalization; and (11) alternate source. For chromium removal, the most economical treatment alternative was found to be anion eachange; and for total chromium removal, two-bed ion exchange was found to be the most eco-nomical. (Lantz-PTT) W91-02727

COST SUPPLEMENT TO TECHNOLOGIES AND COSTS FOR THE REMOVAL OF SELENIUM FROM POTABLE WATER SUPPLIES.

Environmental Protection Agency, Washington, DC. Criteria and Standards Div. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-192496. Price codes: A07 in paper copy, A01 in microfiche. First draft. February 1987. 137 p, 7 fig, 30 tab, 3 consend

Descriptors: \*Costs, \*Economic aspects, \*Potable water, \*Selenium, \*Water treatment, Activated alumina, Coagulation, Cost-benefit analysis, Filtration, Heavy metals, Lime, Reverse osmosis.

The cost estimates are a supplement to the cost section which appears in the November 18, 1985, report entitled, Technologies and Costs for the Removal of Selenium from Potable Water Supplies'. Because selenium is not commonly found in groundwater, capital and operating costs for seleni-

### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5F-Water Treatment and Quality Alteration

um removal technologies were only developed for surface water supplies. Cost estimates for the identified technologies were developed based on information concerning waste disposal, capital costs, and plant size. Costs were not developed for technologies identified as having future potential because additional testing and full-scale evaluations were necessary to determine design criteria and costs. The technologies for which updated costs were developed include: (1) coagulation/filtration, modified for Se (IV) removal; (2) coagulation/filtration, new for Se (IV) removal; (3) activated alumina for Se (IV) removal; (4) lime softening, modified for Se (IV) removal; (5) lime softening, new for Se (IV) removal; (6) reverse osmosis; (7) point-of-use treatment; (8) regionalization; and (9) alternate source. For Se (IV) removal, activated alumina was the most economical treatment alternative for design capacities < 40 million gallons per day (mgd). For systems > 40 mgd, coagulation/filtration was the most economical. Reverse osmosis was found to be the most economical alternative for the removal of Se (VI) and total Se. (Lantz-PTT) total Se. (Lantz-PTT) W91-02728

COST SUPPLEMENT TO REMOVAL OF CAD-MIUM FROM POTABLE WATER SUPPLIES. Environmental Protection Agency, Washington, DC. Criteria and Standards Div. Available from the National Technical Information Control of Control of the National Technical Information Control of Control of National Publishing States (National Information Control of National Inform

Service, Springfield, VA 22161, as PB89-192462. Price codes: A07 in paper copy, A01 in microfiche. First draft. February 1987. 139p, 7 fig, 31 tab, 3

Descriptors: "Cadmium, "Costs, "Potable water, "Water treatment, Coagulation, Corrosion control, Cost-benefit analysis, Economic aspects, Filtration, Heavy metals, Hydrogen ion concentration, Ion exchange, Lime, Reverse osmosis, Water quality.

The cost estimates presented a supplement to the cost section which appears in the April 1, 1985, report entitled "Technologies and Costs for the Removal of Cadmium from Potable Water Sup-Removal or Cadmium from Potable water Sup-plies. Since cadmium is generally found in surface water supplies, capital and operating costs for all technologies were developed for surface waters. Cost estimates for the identified technologies have Cost estimates for the identified technologies have been developed based on information presented concerning waste disposal, capital costs and plant sizes. Costs were not developed for technologies identified as having future potential because additional testing and full-scale evaluations are necessary to determine design criteria and costs. The following cost estimates have been developed: (1) ion exchange; (2) coagulation/filtration, both modified and new; (3) lime softening, both modified and new; (4) reverse osmosis; (5) stabilization of corrosion waters; (6) pH adjustment; (7) corrosion inhibitors; (8) point-of-use; (9) regionalization; and (10) alternate source. The most economical method for treatment for systems with capacities and (10) aiternate source. In e most economical method for treatment for systems with capacities of 0.1 million gallons per day and greater was found to be corrosion inhibitors. Of the cadmium removal technologies, ion exchange was found to be the most economical. (Lantz-PTT) W91-02729

COST SUPPLEMENT TO TECHNOLOGIES AND COSTS FOR THE REMOVAL OF ASBESTOS FROM POTABLE WATER SUPPLIES.

TOS PROM POTABLE WATER SUPPLIES. Environmental Protection Agency, Washington, DC. Criteria and Standards Div. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-192447. Price codes: A06 in paper copy, A01 in microfiche. First draft. February 1987. 115p, 7 fig, 23 tab, 3

Descriptors: \*Asbestos, \*Costs, \*Economic aspects, \*Potable water, \*Water treatment, Coagulation, Cost-benefit analysis, Diatomaceous earth, Filtration, Inhibition, Surface water, Technology.

The cost estimates are a supplement to the cost section which appears in the February 5, 1986, report entitled, Technologies and Costs for the Removal of Asbestos from Potable Water Supplies'. Since asbestos is generally found in surface

water supplies capital and operating costs for all technologies were developed for surface waters. Cost estimates for the identified technologies have been developed based on information presented concerning waste disposal, capital costs, and plant size. Costs were not developed for technologies identified as having hture potential because additional testing and full-scale evaluations are necessary to determine design criteria and costs. The technologies for which updated costs were developed fall into two groups. This grouping was established in the Technologies and Costs document for the removal of asbestos. Group I technologies have b'.en identified as the best generally available treatment methods for reducing asbestos, and include: 1) coagulation/filtration, modified; (2) available treatment methods for reducing asbestos, and include: 1) coagulation/filtration, modified; (2) direct filtration, modified; (3) direct filtration, new; (4) stabilization of aggressive waters; and (5) inhibitors. Group II are more expensive than Group I, and include: (1) coagulation/filtration; (2) filtration, diatomite; (3) regionalization; and (4) alternate source. Direct filtration was found to be the most economical of the removal technologies, below I million gallons per day (mgd) design ca-pacity and above 10 mgd. Between these values, diatomite filtration was found to be the most economical. (Lantz-PTT) W91-02730

DRINKING WATER CRITERIA DOCUMENT

FOR TOLUENE.
Environmental Protection Agency, Cincinnati,
OH. Environmental Criteria and Assessment Office For primary bibliographic entry see Field 5G. W91-02731

DRINKING WATER CRITERIA DOCUMENT FOR 2(2,4,5-TRICHLOROPHENOXY) PROPI-ONIC ACID (2,4,5-TP). Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment

For primary bibliographic entry see Field 5G. W91-02732

DRINKING WATER CRITERIA DOCUMENT

FOR TOXAPHENE.
Environmental Protection Agency, Cincinnati,
OH. Environmental Criteria and Assessment Office.

For primary bibliographic entry see Field 5G. W91-02733

ADAPTATION OF A LEAD-TESTING PRO-

ADAPTATION OF A LEAD-IESTING I GRAM. Hackensack Water Co., Harrington Park, NJ. For primary bibliographic entry see Field 5A. W91-02765

EXPANDING THE ROLE FOR THE POU/POE INDUSTRY.

Environmental Protection Agency, Washington, DC. Office of Drinking Water.

Environmental Geology and Water Sciences EGWSEI, Vol. 16, No. 2, p 133-134, 1990.

Descriptors: \*Water quality, \*Water quality control, \*Water treatment, Chlorination, Marketing, Odor control, Organoleptic properties, Public health, Taste, Water quality standards.

The point-of-use/point-of-entry (POU/POE) industry, along with the bottled water industry, is growing rapidly and has the prospect for continuing high growth for many years into the future. The Environmental Protection Agency believes that POU/POE devices can meet a variety of needs: helping consumers deal with taste and odor problems associated with chlorine and other disinfectants in the water; and dealing with the contamination of private and small water system wells. POU/POE vendors need to enhance and protect their credibility, by ensuring that they know exacttheir credibility, by ensuring that they know exactly what contaminants of concern exist and that their devices will actually remove such contami-nants effectively, and by providing more technical

training for its staff and operators. POU/POE vendors and utilities should support each others' roles, by discussing with each other how the industry by discussing with each other how the industry might improve the quality of their sales techniques and marketing. The POU/POE industry would better serve public health by supporting the appropriate treatment of central water supplies to meet federal and state standards over the long run. (Fish-PTT) W91-02817

ELIMINATION OF SURFACTANTS IN WATER TREATMENT BY ADSORPTION ONTO ACTIVATED CARBON.

Limoges Univ. (France). Lab. de Genie Chimique, Traitement des Eaux.

O. Dusart, S. Souabi, and M. Mazet. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 8, p 721-730, 1990. 10 fig, 1 tab, 13 ref.

Descriptors: \*Activated carbon, \*Adsorption kinetics, \*Surfactants, \*Water treatment, Adsorbents, Drinking water, Model testing, Nonionic surfactants, Organic pollutants, Phenols, Solutes,

Activated carbon adsorption is an effective process for the removal of organic micropollutants found in drinking water supplies. When two solutes are present in the solution with the adsorbent material, complex reactions will exist in the system. The adsorption characteristics of two solutes such as surfactants and phenols in micromolar range in water were determined in batch reactors, using powdered activated carbon as adsorbent. Phenol and conflictions presented by water were elemented in oatch feetors, using powdered activated carbon as adsorbent. Phenol and equilibrium parameters were determined by use of Langmuir or Derylo-Jaronice equations for a single adsorbate. In dilute mixture the adsorption is very strong with the carbon surface. For bisolute organic compound adsorption (anionic-nonionic surfactants, cationic-nonionic surfactant, cationic-nonionic surfactant, cationic-nonionic surfactant, experimental results were compared with two models from the literature. In all cases, the Derylo-Jaronice model can not be conveniently calculated. Only the Jain-Snoeyink model gives relatively good concordance between calculated values and the experimental results. This model shows a part of the competitive sites for the two solutes and a part of the specific one for the compound which has the greater maximum adsorption capacity. It appears that an inhibition effect of a solute by another solute can exist on the specific sites when the coadsorbate is a relatively large molecule. For the evolution of the maximum capacity adsorption two models were maximum capacity adsorption two models were tested: a concurrential equation and another which serves to calculate another parameter, characteristic of inhibition, no effect or promotion, on the specific adsorption sites. (Fish-PTT) W91-02824

IMPACT OF NITROGEN ON THE ADSORPTIVE CAPACITY OF ACTIVATED CHARCOAL.

University of Petroleum and Minerals, Dhahran (Saudi Arabia). Dept. of Civil Engineering. G. Nakhla, J. Qubaih, N. Abu-Zaid, and M.

Abdulappa.

Environmental Technology (Letters) ETLEDB,
Vol. 11, No. 8, p 731-738, 1990. 5 fig, 2 tab, 17 ref.

Descriptors: \*Activated carbon, \*Nitrogen, \*Surfactants, \*Wastewater treatment, \*Water treatment, Adsorbents, Adsorption, Anaerobic conditions, Anoxic conditions, Granular activated carbon, Solutes.

Many researchers have demonstrated the succe many researchers have demonstrated in success-ful treatment of water and wastewaters using sur-face active media, most commonly activated carbon due to its superior microbial attachment properties and its excellent adsorption characteris-tics. The standard static-bottle procedure, which tics. The standard static-bottle procedure, which involves adding a stock solution of adsorbate to different amounts of activated carbon and mixing until equilibrium is attained, does not accurately simulate anoxic conditions which may be prevalent in anaerobic granular activated carbon (GAC) reactors as well as GAC contactors of sufficient depth and biological activity to deplete the dissolved oxygen. The effect of nitrogen on adsorp-tive capacity of activated charcoal was investigati-ed. Adsorption isotherms for phenol on activated charcoal at neutral pH and room temperature (23 C) were conducted using the standard bottle-point technique and a modified method which involves technique and a modified method which involves purging the solution with nitrogen to insure exclusion of oxygen. The observed differences in adsorptive capacities between the two techniques were statistically significant. Nitrogen was observed to reduce the capacity of activated charcoal by as much as 50%. (Fish-PTT)
W91-02825

DEGRADATION OF BLUE GREEN ALGA, MI-CROCYSTIS AERUGINOSA BY FLAGELLATA,

MONAS GUTTULA.
Ibaraki Prefecture Inst. of Public Health, Mito

Ibaraki Freiecuta Militaria (Japan). N. Sugiura, Y. Inamori, R. Sudo, T. Ouchiyama, and Y. Miyoshi. Environmental Technology (Letters) ETLEDB, Vol. 11, No. 8, p 739-746, 1990. 7 fig, 25 ref.

Descriptors: \*Algal control, \*Biodegradation, \*Biological wastewater treatment, \*Cyanophyta, \*Flagellates, \*Microcystis, \*Water treatment, Biological oxidation, Growth rates, Japan, Saturation

The occurrence of blue-green alga, Microcystis, in many eutrophic lakes and reservoirs is responsible for unpleasant odor, fish kills due to sharp decrease many eutrophic lakes and reservoirs is responsible for unpleasant odor, fish kills due to sharp decrease of oxygen, and death of wild birds and cattle due to ingestion of the toxin produced by some strains. Microcystis causes deterioration of congulation, flocculation, filter-clogging, and acceleration of organic chlorides-formation in conventional water treatment processes. Characteristics of degradation of Microcystis aeruginosa by the small flagellata Mastigophora-Monas guttula were examined. Monoxenic M. guttula was isolated from sewage in the biological oxidation facility in the Kasumigaura Water Works, Japan. It was found that M. guttula could efficiently degrade viable algal cells in a short time. The removal of the cells by M. guttula was 90% at 48 hours cultivation. The specific growth rate and generation time of M. guttula were 4.1/day and 4.0 hours, respectively, while maximum specific growth rate and saturation coefficient of the microbe were 4.4/day and 2.4 mg/L with the Lineweaver-Burk equation. It was concluded that M. guttula could effectively utilize M. aeruginosa as a food for its strong affinity and reactivity. (Author's abstract)

LARGE-SCALE BIOLOGICAL NITRATE AND

AMMONIA REMOVAL.
Anjou Recherche, Maisons-Laffitte (France).
F. Rogalla, P. Ravarini, G. De Larminat, and J. Couttelle.

Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 4, p 319-329, August 1990. 10 fig, 2 tab, 50 ref.

Descriptors: \*Ammonia removal, \*Biological treatment, \*Drinking water, \*Nitrates, \*Water treatment, Aeration, Bacteria, Costs, Denitrification, Disinfection, Filtration, France.

In order to treat water containing nitrogen in excess of the European Drinking Water Guidelines excess of the European Drinking Water Guidelines an innovative, large scale biological, nitrogen-removal process has been used. After extensive pilot scale testing and a first full scale (80 cu m/h) demonstration, a 400 cu m/h installation, serving about 50,000 people, was built at Guernes-Dennemont, near Paris. The raw water source is a combimont, near Paris. The raw water source is a combination of percolation from agricultural plains and river bank infiltration, and contains both nitrate and ammonia. The plant consists of two fixed-bed biological reactors in series. An anoxic filter, using ethanol as a carbon source for heterotrophic bacteria, removes nitrates at filtration rates up to 10 m/h. The denitrified water is then polished on acreated two layer filter, packed with activated carbon and sand. Excess carbon from the first stage, together with reduced nitrogen (ammonia and nitrates) is oxidized at this stage before ozonation of the water. A specific dosing method for

biodegradable carbon was developed to monitor the efficiency of the post treatment. Special atten-tion was paid to: (1) nitrate control through im-proved backwash, and (2) reducing the potential for bacterial contamination and after-growth in the distribution network. (Author's abstract) W91-02843

SECONDARY DISINFECTION OF SERVICE RESERVOIRS

Yorkshire Water Authority (England). Western

Journal of the Institution of Water and Environ-mental Management JIWMEZ, Vol. 4, No. 4, p 341-349, August 1990. 4 fig, 4 tab, 6 ref.

Descriptors: \*Disinfection, \*Secondary treatment, \*Water quality, \*Water quality control, \*Water treatment, Bacteria, Case studies, Chemical treatment, Chlorination, Cost-benefit analysis, Hypochlorite, Potable water, Reservoirs, Ultraviolet radiations.

In order to comply with the European Community Directive on the quality of water intended for human consumption, which was embodied in the 1989 Water Act, a number of problems need to be addressed. One such problem is to identify a reliable method of secondary disinfection for service reservoirs which have a history of bacteriological failures. This paper considers the advantages and disadvantages of ultraviolet (UV) and chemical disinfection techniques (both hypochlorite dosing and on site generation of chlorine), together with the basic design features, and presents a case study examining capital and revenue costs. The collated information suggests that UV disinfection is a cost-effective secondary disinfection technique. This suggestion is supported not only by the cost benefits but also by the ease of operation, improved monitoring and control, and elimination of water quality problems associated with chemical techniques. (Author's abstract)

EVOLUTION OF AN OZONE PROCESS AT LITTLETON WATER-TREATMENT WORKS. Bristol Waterworks Co. (England).

D. J. Smith. Journal of the Institution of Water and Environ-mental Management JIWMEZ, Vol. 4, No. 4, p 361-370, August 1990. 6 fig, 1 tab, 10 ref.

Descriptors: \*Disinfection, \*Drinking water, \*Ozonation, \*Ozone, \*Water treatment, Biological treatment, Case studies, Costs, England, Granular activated carbon, Odor control, Organoleptic properties, Potable water, Taste.

properties, Potable water, Taste.

Ozone is increasingly being considered as a means for improving the organoleptic quality of lowland surface waters, often in conjunction with granular activated carbon. The experiences of Bristol Water, who have recently introduced this process at Littleton water-treatment works to resolve long standing taste and odor problems, are described in this paper. The results of the pilot plant studies used to assess the effectiveness of the biological process promoted by ozone are reviewed. Performance requirements specified in the contract for the full scale plant are then outlined, together with a description of the civil works and equipment. Pilot plant studies demonstrated the effectiveness of ozone for disinfection, and that they did not produce unpleasant tastes and odors. Although the chemical revenue costs for ozone and superchlorination were similar, the capital costs of ozone installation were greater. The water quality benefits and operational effectiveness and costs of the ozone process will be evaluated over a 12-month were described in the contract of the period. (Lantz-PTT)

ANALYTICAL SOLUTION FOR ONE-DIMENSIONAL TRANSPORT IN HETEROGENEOUS POROUS MEDIA.

California Univ., Riverside. Dept. of Soil and Environmental Sciences.

# Water Quality Control-Group 5G

Water Resources Research WRERAQ, Vol. 26, No. 10, p 2331-2338, October 1990. 5 fig, 1 tab, 22 ref, append

Descriptors: \*Dispersion, \*Groundwater move-ment, \*Heterogeneity, \*Hydrodynamics, \*Porous media, \*Solute transport, Aquifer characteristics, Aquifers, Diffusion, Dispersion coefficient, Esti-mating, Flow velocity, Mathematical analysis, Pa-rameter estimation, Scaling.

An analytical solution for describing the transport of dissolved substances in heterogeneous porous media with a distance-dependent dispersion rela-tionship can be used to characterize differences in the transport process relative to the classical convection-dispersion equation, which assumes that the hydrodynamic dispersion in the porous medium remains constant. The form of the hydromeatum remains constant. The form of the nyary-dynamic dispersion function used in the analytical solution D(x) = distance-dependent dispersivity x average pore water velocity + diffusion. For models which differ only in how the dispersion models which differ only in how the dispersion function is expressed, erroneous model parameters may result from parameter estimation techniques which assume a constant hydrodynamic dispersion coefficient if the porous medium is more accurately characterized by a distance-dependent dispersion relationship. For such situations, the proposed model could be used to provide an alternate means for obtaining these parameters. The analytical solution should be useful for verifying the numerical accuracy of more comprehensive finite difference and finite element solutions to the transport equations as well as for investigating some aspects of and finite element solutions to the transport equa-tions as well as for investigating some aspects of the scale-dependent transport process. Using scale-dependent dispersion may provide an alternative means for obtaining aquifer parameters for situa-tions where the dispersion coefficient is not spatial-ly constant. (Brunone-PTT) W91-02863

### 5G. Water Quality Control

LARGE-LAKE RESPONSES TO DECLINES IN LARGE-LAKE RESPONSES TO DECLINES IN THE ABUNDANCE OF A MAJOR FISH PLANKTIVORE-THE LAKE MICHIGAN EXAMPLE.
Michigan Univ., Ann Arbor. Center for Great Lakes and Aquatic Sciences.
For primary bibliographic entry see Field 2H.
W91-02073

INFLUENCE OF THE HERBICIDE PARA-QUAT 'GRAMAXON' ON GROWTH AND METABOLIC ACTIVITY OF THREE CHLORO-

Institute of Oceanography and Fisheries, Cairo (Egypt). Lab. of Aquatic Plants. For primary bibliographic entry see Field 4A. W91-02085

STIMULATION OF BIOLOGICALLY ACTIVE ZONES (BAZ'S) IN POROUS MEDIA BY ELECTRON-ACCEPTOR INJECTION.

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.

J. E. Odencrantz, W. Bae, A. J. Valocchi, and B.

E. Rittmann

E. Kuttmann.

Journal of Contaminant Hydrology JCOHE6, Vol.

6, No. 1, p 37-52, July 1990. 5 fig, 1 tab, 18 ref.

University of Illinois Water Resources Center
Grant No. S109, Illinois Hazardous Waste Research and Information Center Project No.

HW88.026.

Descriptors: \*Biofilms, \*Bioremediation, \*Cleanup operations, \*Groundwater pollution, \*Nitrates, \*Porous media, \*Water pollution treatment, Acetates, Computer models, Microbial degradation, Organic compounds, Organic solvents, Solute transport, Solvents, Substrates.

In situ bioreclamation is a promising new technique for enhancing the cleanup rate of aquifers contaminated with organic pollutants, and involves injecting the materials necessary to increase the microbiological activity in the subsurface. A methodology involving laboratory-column experiments

#### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5G-Water Quality Control

and computer modeling was utilized to investigate the formation of denitrifying biologically active zones (BAZs) in a porous medium, when a limiting electron acceptor NO3(-) is njected along the flow path. Laboratory experiments conducted in a unique one-dimensional porous-medium column demonstrated the relationship between lateral injection of NO3(-) and the location and extent of BAZs when acetate was present as the sole carbon source. The phenomena of BAZ formation and the utilization of limiting and non-limiting substrates were expressed quantitatively in a computer model that coupled principles of one-dimensional solute transport and steady-state biofilm kinetics. A new, transport and steady-state biofilm kinetics. A new, highly efficient solution algorithm was developed to solve directly for the steady-state profiles of the limiting substrate and biofilm mass, as well as for the non-limiting substrate. The predictive ability of the non-inning substrate. In e predictive ability of the model was verified by successful simulation of particular laboratory experiments using independently determined kinetic parameters for acetate. Research results indicate that injection of limiting substrate along the groundwater flow path is a viable means of establishing spatially distributed BAZs for enhanced in situ bioreclamation. (Author's abstra abstract)

TRANSFORMATION KINETICS OF TRACE-LEVEL HALOGENATED ORGANIC CON-TAMINANTS IN A BIOLOGICALLY ACTIVE ZONE (BAZ) INDUCED BY NITRATE INJEC-

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.

W. Bae, J. E J. Valocchi. Bae, J. E. Odencrantz, B. R. Rittmann, and A.

J. Vaioccin.

Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 1, p 53-68, July 1990. 5 fig, 4 tab, 19 ref. Illinois Hazardous Waste Research and Information Center Project No. HW88.026, University of Illinois Water Resources Center Grant No. S109.

Descriptors: \*Biofilms, \*Bioremediation, \*Biotransformation, \*Cleanup operations, \*Groundwater pollution, \*Halogenated hydrocarbons, \*Kinetics, "Nitrates, "Water pollution treatment, Ace-tates, Computer models, Microbial degradation, Organic compounds, Organic solvents, Porous media, Solute transport, Solvents, Substrates.

Halogenated organic compounds are widely used as industrial solvents, dry cleaning solvents, metal degreasing agents, and pesticides. In situ bioreclamation is a promising approach to clean up aquifers contaminated with these compounds. When the compound is present in a very low concentration that is insufficient to meet the minimum energy requirements needed to maintain a mum energy requirements needed to maintain a steady-state biomass, the compound may be de-graded by a secondary utilization mechanism. Laboratory experiments and numerical modeling were conducted to evaluate the secondary utilization of eight trace-concentration halogenated solvents in a denitrifying biologically active zone (BAZ) in-duced by nitrate injection into an acetate-fed porous-medium column. Results of column experi-ments indicated that carbon tetrachloride was removed most completely by the denitrifying BAZ, while bromoform, dibromoethane, tetrachlorethane, trichloroethene, 1,2-dichlorobenzene and 1,3-dichlorobenzene were removed, but to lesser dedichlorobenzene were removed, but to lesser de-grees. 1,1-l-trichloroethane removal was slight. Compounds were removed to higher degrees when the BAZ contact time was increased. The steady-state, one-dimensional solute transport equation was solved using an iterative finite difference scheme and by employing a quasilinearization technique for the biofilm reaction term. The model solved directly for the steady-state profiles of sec-ondary substrates. One set of experimental results ondary substrates. One set of experimental results was used to obtain best-fit values of kinetic parameters which were then used to predict the removal at different liquid flow velocities. The model predictions correctly described all experimental trends: removal of the halogenated compounds only in the BAZ, greater removal with increased BAZ context time and reduced receifer removal BAZ contact time, and reduced specific removal rates caused by diffusion limitation in the biofilm. (Tappert-PTT) W91-02162

ORGANOPHOSPHORUS DETECTION OF PESTICIDE DETOXIFYING BACTERIAL COLONIES, USING UV-PHOTOGRAPHY OF PARATHION-IMPREGNATED FILTERS. Texas A and M Univ., College Station. Dept. of Biochemistry and Biophysics.
For primary bibliographic entry see Field 5B.

W91-02200

ECOLOGY OF A SOUTHERN OHIO STREAM RECEIVING FLY ASH POND DISCHARGE: CHANGES FROM ACID MINE DRAINAGE CONDITIONS.

American Electric Power Service Corp., Colum-bus, OH. Environmental Engineering Div. For primary bibliographic entry see Field 5C. W91-02208

USE OF THE INDEX OF BIOTIC INTEGRITY TO ASSESS THE IMPACT OF LAND MAN-AGEMENT ACTIVITIES ON LOW ORDER STREAMS IN NORTHERN IDAHO.

SIREAMS IN NORTHERN IDAHO.

Idaho Univ., Moscow. Dept. of Fish and Wildlife.

D. H. Bennett, and T. R. Fisher.

Available from National Technical Information
Service, Springfield, VA 22161 as PB90-240052/
AS. Price codes: A05 in paper copy, A01 in microfiche. Idaho Water Resources Research Institute,
Moscow, Completion Report, October 1989. 79p,
16 tab, 11 fig. 31 ref, 10 append. USGS Contract
no. 14-08-0001-G1419. USGS Project No. G1419166.

Descriptors: \*Bioindicators, \*Idaho, \*Index of biotic integrity, \*Land management, \*Land use, Fish, Stream biota, Stream fisheries, Stream profiles, Streams, Water quality.

The Index of Biotic Integrity (IBI) was adapted to the faunal characteristics of northern Idaho headwaters streams. Stream bioto was sampled from June 1987 through September 1987. The original Index of Biotic Integrity, as developed for midwestern U.S. streams, was unsuitable for use in northern Idaho. Only four of the 12 metrics included in the original IBI reflected changes in the biotic integrity of northern Idaho streams. The original IBI, although significantly correlated with measures of stream quality, was too insensitive and biotic integrity of northern Idaho streams. The original IBI, although significantly correlated with measures of stream quality, was too insensitive and classified lower quality streams as being in 'good to excellent' health. The original IBI was modified to contain eight metrics to reflect the health of the fish, amphibian, and aquatic macroinvertebrate communities. Also, expectation criteria of three metrics were adjusted for relative stream size. Our modified IBI seems to assess the health of northern Idaho headwater streams adequately. The modified IBI detected changes in stream health, as index scores were significantly correlated with road density and percent harvest of the drainages. Also, the modified IBI was more highly correlated with measures of impact and less significantly with measures of stream size than Shannon diversity of fishes by biomass of numbers, the Index of Well Being, Brillouin diversity of both fishes and aquatic macroinvertebrates. The modified Index of Biotic Integrity offers managers a technique to evaluate stream health with limited vertebrate and invertebrate sampling. Because the index was developed brate sampling. Because the index was developed from data collected in northern Idaho streams with generally nonerosive rock types, it is not known how well this index would classify stream health in other regions of Idaho or other streams in the Pacific Northwest. (USGS) W91-02242

AGRICULTURAL PESTICIDES AND GROUNDWATER IN NORTH CAROLINA: IDENTIFICATION OF THE MOST VULNERA-RIF ADEAS North Carolina Water Resources Research Inst.,

D. H. Moreau, and L. E. Danielson.

D. H. Moreau, and L. E. Damieton. Available from National Technical Information Service, Springfield, VA 22161 as PB90-235359/ AS. Price codes: A03 in paper copy, A01 in micro-fiche. North Carolina Water Resources Research Institute Report No. 252, May 1990. 31p, 12 fig, 6 tab, 11 ref, append.

Descriptors: \*Agricultural chemicals, \*Ground-water, \*Groundwater pollution, \*Monitoring, \*North Carolina, \*Pesticides, \*Water pollution control, \*Water pollution sources, Cost efficiency,

This report describes the methods and findings of research aimed at targeting areas in North Carolina where groundwater is vulnerable to contamination by agricultural pesticides. Areas that are mos likely to be contaminated are identified by combin by agricultural pesticities. Areas that are most-likely to be contaminated are identified by combin-ing county-level estimates of pesticide use with indices of groundwater vulnerability. Results re-ported are intended as guides for more detailed research activities and for design of monitoring programs such as the one proposed by the North Carolina Interagency Working Committee on Groundwater Monitoring. The report presents re-sults of research using the methods and criteria suggested. Estimates of quantities and spatial pat-terns of use are reported for the most heavily used pesticides that have the potential to leach into groundwater. Counties in North Carolina having the highest potential for groundwater contamina-tion are identified. It is recommended that primary data on the sale and use of pesticides in North Carolina should be collected: that groundwater data on the sale and use of pesticides in North Carolina should be collected: that groundwater caronna should be collected; that groundwater sampling should be implemented with a sustained funding base; and that indicators of vulnerability presented should be refined to pinpoint priority sites for monitoring. Several options for cost-effective information gathering about pesticide use in the state is suggested. (USGS) W91-02245

STATE-OF-THE-ART OF HYDROLOGY AND HYDROGEOLOGY IN THE ARID AND SEMI-ARID AREAS OF AFRICA.

For primary bibliographic entry see Field 2A. W91-02288

PROBLEMS OF MAINTENANCE OF WATER QUALITY IN ARID AND SEMI-ARID REGIONS OF WEST AFRICA.

Ghana Univ., Legon. Dept. of Botany.

C. M. Amoah.

C. M. Amoan.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 722-735, 3 fig. 4 tab, 13 ref.

Descriptors: \*Africa, \*Developing countries, \*Sahel, \*Sudan, \*Water pollution control, \*Water pollution sources, \*Water quality management, Agriculture, Arid lands, Drinking water, Educa-tion, Human diseases, Path of pollutants, Potable water, Semiarid lands, Social aspects.

The ecological problems of the Sahelian and Sudanian zone (SSZ) of West Africa have received considerable attention. In the arid and semi-arid regions of Africa, as in most other places, most water bodies are put to multiple uses. Fresh water is used for drinking, for livestock, in agriculture, transport, power generation, irrigation, industry, and recreation. The great demand on a limited and recreation. The great demand on a limited water supply leads to various forms of degradation. Possible causes of contamination were examined and mitigating measures considered. The physical, social, and economic problems of maintaining water quality were examined. Specific recommendations made are as follows: (1) inhabitants should be educated about some of the human habits that lead to water pollution, such as throwing used wash water back into rivers; (2) bathing should be discouraged in drinking water sources; ing used wash water back into rivers; (2) bathing should be discouraged in drinking water sources; (3) water for human consumption should be separated from that used for livestock; (4) people infected with guinea-worm and bilharzia should be educated not to enter the water; (5) water should be filtered and boiled before drinking to kill disease-causing organisms; (6) water-borne disease prevention should be considered when expanding water supplies; and (7) government housing rollive water supplies; and (7) government housing policy should embody a supply of good drinking water. (See also W91-02288) (Rochester-PTT)

TELETRANSMISSION OF HYDROLOGICAL DATA WITHIN THE FRAMEWORK OF THE PROGRAMME TO COMBAT ONCHOCERCIASIS (TELETRANSMISSION DES DONNEES HYDROLOGIQUES DANS LE CADRE DU PROGRAMME DE LUTTE CONTRE L'ON-CHOCERCOSE).

CHOLERCOSE.,
Institut Francais de Recherche Scientifique pour le
Developpement en Cooperation, Lome (Togo).
Centre ORSTOM du Togo.
For primary bibliographic entry see Field 7B.
W91-02353

BIOLOGICALLY AVAILABLE PHOSPHORUS RETENTION BY THE KIS-BALATON RESER-

Ulster Univ., Coleraine (Northern Ireland). Lim-For primary bibliographic entry see Field 2H. W91-02375 nology Lab.

FRY COMMUNITIES AS A BIOMANIPULATING TOOL IN A TEMPERATE LOWLAND

Lodz Univ. (Poland) Inst. of Environmental Riol-

ogy. For primary bibliographic entry see Field 2H. W91-02381

PREDICTION ON EUTROPHICATION OF RESERVOIR YUQIAO.
Tianjin Inst. of Environmental Protection and Sci-

x. Zhu, and R. Hou. Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 783-792, 1990. 5 fig. 4 tab, 7 ref.

Descriptors: "Erosion control, "Eutrophication, "Limnology, "Model studies, "Nutrients, "Reservoir operation, "Reservoir, "Soil erosion, "Stream erosion, "Water pollution control, "Water quality management, "Water quality trends, Agricultural practices, Agricultural runoff, China, Fertilizers, Nitrogen, Nonpoint pollution sources, Pesticides, Phosphorus, Yuqiao Reservoir.

The impact of P and N inputs from nonpoint sources of agricultural runoff on the eutrophication of Yuqiao Reservoir in China was investigated. The magnitude of nutrient input from the 2060 sq of Yuqiao Reservoir in China was investigated. The magnitude of nutrient input from the 2060 sq. km drainage area of the reservoir was evaluated, based on the synchronous measure of water quality and quantity. Loading rates for N and P to the reservoir surface were 4.31 and 0.79 g/sq m/yr, respectively. The future trophic state of the reservoir under changed hydrologic conditions, i.e., after a project to divert water from the Luan River into the Tianijin, is predicted by the nutrient load-eutrophication response model (the Dillon Model). The results indicate that P loading must be reduced by about 65% in the Yuqiao Reservoir for it to change from eutrophic to mesotrophic. Management strategies for maintaining water quality of the reservoir include: (1) contour farming to reduce erosion potential; (2) leaving buffer strips of trees and shrubs along streams to reduce soil erosion; (3) grass seeding or other vegetation planting to stabilize areas of stream and reservoir banks to reduce soil-particle flushing and erosion; (4) use of culverts and other engineering structures to control water flow and thereby reduce erosion; (5) nutrient management practices, including fertilizer formulation, application; and (6) pesticide management practices, including epiciation methodology, timing, and rate of application. (Author's abstract) W91-02383

WATER QUALITY IN THE SANCE RESER-VOIR (NORTH MORAVIA). Ceskoslovenska Akademie Ved, Prague. Hydro-

Ceskosiovenska Akademie ved, Frague. Hydrobiologicka Lab. L. Simanov, C. Budejovice, and J. Kantorek. Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 869-874, 1990. 2 fig. 4 tab, 6 ref.

Descriptors: \*Czechoslovakia, \*Drinking water, \*Sance Reservoir, \*Water quality, Bacteria, Industrial wastewater, Nitrates, Ostravice River, Phos-

phates, Pollution index, Recreation, Water pollution sources.

The Sance Reservoir was built in 1969 as a drinking water supply from the Ostravice River, Czechoslovakia. Before dam construction was begun, the water quality of the reservoir was predicted from a hydrobiological investigation of the territory. These water quality investigations were conducted from 1972 to 1976, and again from 1980 to 1984. Tributaries of the reservoir were found to have maintained excellent water quality since 1954. Only dissolved matter and bacterial counts showed a small increase. The Sance Reservoir has had very good water quality, in agreement with the predictions. good water quality, in agreement with the pred good water quanty, in agreement with the predictions (oligotrophy, oligo-betamesosaprobity). Only bacterial counts, nitrates, phosphates, and the saprobic index have shown a slight increase. In the future, only two dangers appear to exist: an intuture, only two dangers appear to exist: an in-crease in air pollution from a nearby industrial agglomeration, and an increase in water pollution as a result of recreation in the drainage area. The reservoir itself does not contribute to the deteriora-tion of the water quality in the Ostravice River below the dam. (Sand-PTT) W91\_02392

RELATIONSHIP OF RESERVOIR BIOGEO-CHEMICAL PROCESSES TO THE STRUCTUR-AL INTEGRITY OF THE WORLD'S FIRST TO-TALLY ROLLER COMPACTED CONCRETE

Army Engineer District, Portland, OR. Reservoir Regulation and Water Quality Section. For primary bibliographic entry see Field 8F. W91-02399

PATTERNS AND CONTROLS OF NITROGEN IN TALLGRASS PRAIRIE STREAMS.

Kansas State Univ., Manhattan. Div. of Biology. For primary bibliographic entry see Field 2H. W91-02405

SITING CONSIDERATIONS FOR RESOURCE RECOVERY FACILITIES.

STV. Inc., Pottstown, PA.

For primary bibliographic entry see Field 5E. W91-02421

SEWAGE LAGOON TO SPLENDID LAKES. D. O'Dell, M. J. Hood, B. L. Murray, and S. M.

Public Works PUWOAH, Vol. 121, No. 10, p 105-106, September 1990. 1 fig.

Descriptors: \*Boating, \*Lake restoration, \*Missou-ri, \*Recreation, \*Swimming, \*Wastewater lagoons, Algal control, Environmental protection, Fish con-trol agents, Lakes, Rotenone, Sludge, Twin Lakes Recreation Area, Watershed protection.

A former sewage lagoon has been turned into the Twin Lake Recreation Area, a 60 acre tract within the Columbia, Missouri city limits, that includes a 6-acre swimming lake with a sand beach and a 20-acre L-shaped lake where nonmotorized craft can acre L-shaped lake where nonmotorized craft can take advantage of prevailing winds. The lakes were reclaimed from an abandoned sewage lagoon in the early 1980s. Sludge was removed after draining the lagoon. The sludge was evenly spread under the proposed parking area. To assure minal environmental impact, the sludge was covered with 12-18 inches of clay soil that had also been removed from the lagoon bottom. As an extra precaution, the site grading was designed to separate the watershed areas, thus eliminating any chance of sewage nollution entering the lake sites. rate the watershed areas, thus eliminating any chance of sewage pollution entering the lake sites. Fish problems in the lake were controlled by rotenone applications. Copper complex based products have been used to control algae. A floating spray fountain will be added to the swimming lake for additional algae control. By introducing additional oxygen to the water, some of the nutrients present should be oxidized and made unavailable to the algae. (Mertz-PTT) algae. (Mertz-PTT) W91-02425

## Water Quality Control—Group 5G

DEGRADATION OF PESTICIDE WASTE TAKEN FROM A HIGHLY CONTAMINATED SOIL EVAPORATION PIT IN CALIFORNIA. California Univ., Davis. Dept. of Environmental

W. Winterlin, J. N. Seiber, A. Craigmill, T. Baier. and J. Woodrow.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 5, p 734-747, September 1989. 6 fig, 9 tab, 9 ref.

Descriptors: \*Biodegradation, \*California, \*Clean-up operations, \*Decontamination, \*Evaporation ponds, \*Land disposal, \*Pesticide residues, \*Soil contamination, \*Toxic wastes, \*Waste disposal, Acids, Hydrogen ion concentration, Lime, Nutri-ents, Organic matter, Soil amendments, Soil prop-erties, Soil types, Soil water.

The primary method for disposing of liquid pesti-cide wastes in California has been the dumping of the liquid materials into soil evaporation pits, ditches, and ponds, most of which are unlined and have been in use for many years. An investigation was undertaken to determine the optimum conditions for degrading high concentrations of pesticides in the soil. Soils at a northern California site were removed from the evaporation pit and placed were removed trom the evaporation pit and piaceta in trays. Additional trays were prepared which contained similar soil fortified with six pesticides (atrazine, trifluralin, malathion, diazinon, chlorpyr-ifos, and parathion) and which were subjected to various soil amendments, including organic matter, lime, acids, and nutrients, under moist and flooded conditions. The effects of the soil amendments on the pesticide-fortified soils were generally pesticide dependent. The pH of the soils was a major factor dependent. The pri of the soils was a major factor in degradation and there was a pH difference between the anaerobic and aerobic soils. Under anaerobic conditions, half lives of most pesticides were shorter in the soils with highest pH, while the opposite was true under aerobic conditions. Treatment with manure, amonatum phosphate, and lime opposite was true under aerosic continons. Tear-ment with manure, ammonium phosphate, and lime was very effective in reducing the half lives of pesticides in soils from the evaporation pit (under pesticides in soils from the evaporation is both aerobic and anaerobic conditions); treatment with corameal and ammonium phosphate was less effective. Under alternating moist and flooded soil to be treatment combined with conditions, a heavy lime treatment combined with a source of organic substances (such as manure) should provide an effective degradation of the pesticides in a contaminated toxic waste site. (Author's abstract)

SHORT TERM RESPONSE TO EUTROPHICA-TION ABATEMENT.

Senter for Industriforskning, Oslo (Norway). K. L. Seip, H. Sas, and S. Vermij. Aquatic Sciences AQSCEA, Vol. 52, No. 3, p 199-220, 1990. 6 fig. 2 tab, 21 ref, append.

Descriptors: \*Chlorophyll a, \*Eutrophic lakes, \*Lake restoration, \*Limnology, \*Model studies, \*Phosphorus, Chlorophyll, Lakes, Mathematical studies, Regression analysis, Water chemistry.

Reduction of nutrient loadings to lakes Reduction of nutrient loadings to lakes is a common restoration measure for eutrophic lakes. On a chlorophyll-a/total phosphorus graph a positive response would be represented by a displacement towards the origin. The results of a new model for predicting the short term interannual changes in chlorophyll-a in lakes after reductions in total phosphorus were compared with predictions made by least squares regression models. In the new method, slopes of chlorophyll-a/total-phosphorus graphs were denicted in frequency total-phosphorus graphs were denicted in frequency totalphosphorus graphs were depicted in frequency dia-grams and used to extract information on the exgrams and used to extract information on the expected, short term chlorophyll-a/total phosphorus response. The short term response for nine shallow (< 10 m deep) and nutrient rich lakes to changes in total phosphorus was found to be: chlorophyll-a = 0.49(total phosphorus) + 17.3, and for nine deep, phosphorus-limited lakes: chlorophyll-a = 0.08(total phosphorus) + 3.5. If the total phosphorus-reduction was known to be greater than 10 mg/cu m, the expected slope increased to 0.58 for shallow lakes and to 0.26 for deep lakes. The slope, 0.58, was 8% lower than the slope for the long term response calculated by regression for the shal-

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low lakes. For deep lakes the slope, 0.26, was 2 to 3 times higher than that calculated by regression, indicating that reductions in total phosphorus for deep lakes gave greater effects than least squares regression equations suggest. The reduction in total phosphorus gave about 80% probability that a reduction in chlorophyll-a would be observed next year. For shallow, phosphorus-limited lakes this reduction was about 30 mg/cu m (5% of average initial in-lake total phosphorus concentration), and for deep lakes about 14 mg/cu m (35% of average initial in-lake total concentration). (Mertz-PTT)
W91-02447 deep lakes gave greater effects than least squares

POSSIBILITIES FOR REGENERATION OF FLOODPLAIN FORESTS WITHIN THE FRAMEWORK OF THE FLOOD-PROTECTION MEASURES ON THE UPPER RHINE, WEST CERMANY

Institute for Floodplains Ecology, Rastatt (Germa-

For primary bibliographic entry see Field 4A. W91-02472

STREAMSIDE MANAGEMENT UNITS IN THE PACIFIC NORTHWEST.
Forest Service, Portland, OR. Pacific Northwest

For primary bibliographic entry see Field 6B. W91-02497

SENSITIVITY ANALYSIS OF NINE DIVERSI-TY AND SEVEN SIMILARITY INDICES, National Park Service, Fort Collins, CO. Water Resources Div. For primary bibliographic entry see Field 2H. W91-02534

EFFECTS OF WASTEWATER TREATMENT AND SEAWATER DILUTION IN REDUCING LETHAL TOXICITY OF MUNICIPAL AND SEAWATER DILUTION IN REDUCING LETHAL TOXICITY OF MUNICIPAL WASTEWATER TO SHEEPSHEAD MINNOW (CYPRINODON VARIEGATUS) AND PINK SHRIMP (PENAEUS DUORARUM). Environmental Research Lab.-Narragansett, Newport, OR. Pacific Div. For primary bibliographic entry see Field 5D. W91-02535

OPERATIONAL WATER QUALITY MANAGE-MENT: CONTROL OF STORM SEWAGE AT A WASTEWATER TREATMENT PLANT. For primary bibliographic entry see Field 5D. W91-02541

REVISION OF THE SAPROBIC SYSTEM (EINE REVISION DES SAPROBIENSYSTEMS), Landesamt fuer Wasser und Abfall Nordrhein-Westfalen, Duesseldorf (Germany, F.R.). G. Friedrich.

G. Friedrich. Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 23, No. 4, p 141-152, August 1990. 5 tab, 27 ref. English summary.

Descriptors: \*Benthos, \*Bioindicators, \*Limnology, \*Monitoring, \*Pollution index, \*Saprobic index, \*Water quality, Germany, Heterotrophic bacteria, Running waters, Statistical analysis, Water chemistry.

The saprobic system, originally established in 1902, and revised later on, has been screened and revised within the standardization of the German methods within the standardization of the German methods for the examination of water, wastewater and sludge. A working group, consisting of experi-enced limnologists, made use of the results from long-term biological water quality studies in West Germany, which included statistical data manage-ment and data from chemical analysis of water. The revision of the list of indicators was based upon the following criteria: only benthic organisms are included, pertinent to the current investigation: apon the following criteria: only deathire organisms are included, pertinent to the current investigation; organisms should be widespread over Central Europe; organisms should be identifiable with available keys; photoautotrophic species are excluded, according to the definition of saproby as

the intensity of the heterotrophic activity, and in order to avoid overlapping with the indication of trophy; and benthic organisms included should have as narrow as possible a saprobic valance. A 20 point distribution is used to characterize the saprobic valency between oligosaprobic and polysaprobic. The indicator values (g) are graduated 1, 2, 4, 8, and 16 in order to discriminate between species with narrow saprobic valency and those with broader valency. The range of validity and use of the saprobic index are limited to permanent or temporary running waters. The difficulties arising in alpine or quasi standing waters are recognized as well. The revision of the saprobic index will be completed as DIN 38410 part 2. (Author's abstract) W91-02546

TOXICOLOGICAL RISK/BENEFIT-ASPECTS OF DRINKING WATER CHLORINATION AND OF ALTERNATIVE DISINFECTION PROCE-

Forschungsinstitut fuer Mikrobiologie und Hygiene, Bad Elster (German D.R.).
For primary bibliographic entry see Field 5F.
W91-02547

MONITORING PROGRAM ASSESSES WATER

MUNITURING PROGRAM ASSESSES WATER QUALITY PROGRESS. Milwaukee Metropolitan Sewerage District, WI. For primary bibliographic entry see Field 3D. W91-02561

TOXIC-SUBSTANCE CONTROL FOR THE OHIO RIVER

Ohio River Valley Water Sanitation Commission, P. Tennant, A. Vicory, C. Norman, and P.

McConocha. Water Environment & Technology WAETEJ, Vol. 2, No. 10, p 59-63, October 1990. 5 fig.

Descriptors: \*Environmental policy, \*Interstate commissions, \*Ohio River, \*Toxic wastes, \*Water pollution control, \*Water quality control, Data collections, Interagency cooperation, Nonpoint pollution sources, Water analysis, Water pollution prevention, Water quality, Water treatment.

Before the widespread application of pollution abatement technology, the Ohio River and its trib-utaries suffered severe water quality degradation as utaries suffered severe water quanty degradation as a consequence of the basin's economic growth. In 1948, eight states signed a compact pledging cooperation to restore and maintain the quality of the valley's waters. The Ohio River Valley Water Sanitation Commission (ORSANCO) was created Sanitation Commission (ORSANCO) was created to oversee the compact's implementation and consists of three members from each state and three members representing the federal government. In the commission's early years, the major challenge was to provide some degree of treatment for the many waste discharges to the Ohio River and its tributaries. In the late 1970s, concerns over the presence of toxic substances in water caused the commission to appoint a task force to develop a toxics-control strategy. For the Ohio River as a whole, the most frequently detected toxic subtoxics-control strategy. For the Ohio River as a whole, the most frequently detected toxic substances were zinc, copper, and chloroform, each of which was found in over 70% of the samples analyzed. It was decided to initiate investigations of each of the 10 segments used in the initial report completed for the 117-mile segment from Wheeling to Parkersburg, WV, and the 87-mile segment from Pittsburgh, PA to Wheeling, WV. A third segment investigation, covering the 100 miles from Cincinnati to Louisville has been initiated. Results from the first two segment investigations indicate that the first two segment investigations indicate that nonpoint sources of toxics including runoff and groundwater contributions may be as significant as point-source discharges in determining levels of toxics in the Ohio river. Future field studies under toxics in the Ono over ruture field studies under the commission's toxic substances control program will make greater use of sediment sampling and will address smaller study areas in order to better use limited funds for laboratory analysis. (Ver-

MODELING INACTIVATION OF GIARDIA LAMBLIA.

Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab. For primary bibliographic entry see Field 5F. W91-02570

SEDIMENT OXYGEN DEMAND MODEL: METHANE AND AMMONIA OXIDATION. Manhattan Coll., Broxn, NY. Environmental Engineering and Science Program.
For primary bibliographic entry see Field 2H.
W91-02576

ACCURATE METHOD FOR CALCULATION OF SATURATION DO.

Wuxi Pearl Lustre Pigment Factory (China). H. Hua. Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 5, p 988-990, 1990. 2 tab,

Descriptors: \*Dissolved oxygen, \*Mathematical analysis, \*Mathematical equations, \*Water quality, Monitoring, Oxygen, Precision, Water quality con-

Dissolved oxygen (DO) concentration is an impor-tant water quality index. In calculating the reaera-tion rate, an accurate saturated DO value is crucial. Engineers have been seeking a reliable method for the accurate calculation of the saturatcial. Engineers have been seeking a reliable method for the accurate calculation of the saturated DO concentration. Based on a careful study of the mechanism of gaseous solubility, a new formula for calculating the saturation DO is deduced. According to this study, it is assumed that two physical processes exist between the gaseous and the liquid phases: (1) the dissolution of gas, which depends on its diffusion rate; and (2) the vaporization of the gaseous component, which has already dissolved in the liquid phase. When the vaporization rate is equal to the diffusion rate, a dynamic equilibrium between the gaseous phase and liquid phase is established. Based on these assumptions, the gaseous solubility equation is created. Based on this equation, a new formula for calculating the saturation value of oxygen was obtained which is applicable to both seawater and fresh water from O C to 50 C. The new formula gives an accuracy higher than that obtained by previous equations. The average relative error is only 0.31%, and the average absolute error is 0.03 mg/L. (Lantz-PTT) W91-02577

GUIDANCE DOCUMENT FOR PROVIDING ALTERNATIVE WATER SUPPLIES. Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-167969. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/540/G-87/006, February 1988. 3 fig, 3 tab, 19 ref, append.

Descriptors: \*Decision making, \*Water quality, \*Water supply development, Drinking water, Po-table water, Remedies, Superfund, Water quality control, Water supply.

EPA has developed guidelines for providing information, when it becomes necessary, to develop or obtain alternate water supplies where releases of hazardous substances or pollutants have resulted in the closing of drinking water wells, or has contaminated a principal drinking water supply. This information was prepared to assist Superfund contractors and on-scene Federal, State and local officials with the planning and implementation of alternate water supplies at uncontrolled hazardous waste sites. Guidance is specifically provided for those sites that do not require a time critical removal action, but do require provision of an alternate water supply as either a non-time-critical removal action, but do require provision of an alternate water supply as either a non-time-critical removal action of 6 months or more, or a remedial action before implementation of a final remedy can action before implementation of a final remedy can be achieved (actions performed at National Priori-ty List sites where short-term threats to the human population exist). These remedial actions are used to provide faster responses than can be achieved

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with normal remedial actions. The decision making with normal remedial actions. The decision making process used in this document discusses the determination of water supply needs, screening and evaluating alternatives, and remedy implementation. (Author's abstract)

INFORMATION COLLECTION REQUEST FOR: NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR INORGANIC CHEMICALS.

Miller (Wade) Associates, Inc., Arlington, VA. For primary bibliographic entry see Field 7B. W91-02602

EVALUATION OF THE NUTTING LAKE DREDGING PROGRAM.
Baystate Environmental Consultants, Inc., East

Baystate Environmental Consultants, Inc., East Longmeadow, MA. Available from the National Technical Information Service, Springfield, VA 22161, as PBs9-181895. Price codes: Al 0 in paper copy, A01 in microfiche. February, 1987. 117 p, 32 fig, 3 tab, 16 ref, 3

Descriptors: \*Dredging, \*Lake restoration, \*Nutting Lake, \*Water quality, Dissolved oxygen, Domestic wastes, Lake sediments, Performance evaluation, Recreation, Sediment control, Wastewater disposal. Water quality control.

The Nutting Lake Program was conceived as a means to both develop and demonstrate an effective inland dredging method, and to restore recreational utility to a suburban lake. Between 1978 and 1986 an estimated total of 361,000 cubic yards and 1986 an estimated total of 361,000 cubic yards (276,000 cu m) of soft sediment was removed from Nutting Lake by hydraulic dredging. Except for occasional sanitary sewer overflows and diminishing residual inputs from onsite wastewater disposal systems, the influence of domestic wastewater on Nutting Lake has been eliminated. However, the Nutting Lake has been eliminated. However, the dredging operation was not as successful. Considerable quantities of soft sediment remain in the lake, and the actual volume of sediment removed by dredging may be as low as 224,000 cu yds. Stormwater inputs and dredging activities appear to have destabilized the system during the project; therefore, water quality is more variable and not appreciably better than before the program commenced. The only statistically significant change in water quality was an increase in the dissolved oxygen saturation level at the surface of the east basin and throughout the west basin of Nutting Lake. Future monitoring will be needed to evaluate long-term trends in water quality, but at this Lake. Future monitoring will be needed to evaluate long-term trends in water quality, but at this time the water quality benefits of the program appear negligible. However, reduction of macrophyte nuisances in selected areas has fostered increased use of Nutting Lake for swimming and booting (I artz. PTT). boating. (Lantz-PTT) W91-02617

VOLUNTEER LAKE MONITORING PROGRAM, 1988, VOLUME VI: SOUTHWESTERN ILLINOIS REGION.

Southwestern Illinois Metropolitan and Regional Planning Commission, Collinsville. For primary bibliographic entry see Field 7B. W91-02618

BUGLE LAKE PROTECTION AND REHABILI-TATION PROJECT.
Independence Public Inland Lake Protection and Rehabilitation District, WI.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-209084.
Price codes: A05 in paper copy, A01 in microfiche. Final Report, March 1982. 86 p. 5 append. EPA Grants 0000567701 and 0080574201.

Descriptors: \*Bugle Lake, \*Erosion control, \*Lake rehabilitation, \*Lake restoration, \*Sediment control, \*Watershed management, Bank stabilization, Dredging, Lake sediments, Shore protection, Wis-

Bugle Lake, Wisconsin, had an average depth of three feet due to sedimentation caused by upland

and streambank erosion. A restoration project consisting of: implementing the best management practices on the watershed; streambank and shore stabilization; and stoping and seeding to control erosion. In addition, the lake was dredged to a depth of 6 feet. Lake recreation was enhanced subsequent to the project's completion. This report also includes the initial feasibility study. (Lantz-PTT) W91-02621

ECONOMIC BENEFIT CONSIDERATIONS IN SELECTING WATER QUALITY PROJECTS. INSIGHTS FROM THE RURAL CLEAN WATER PROGRAM.

WATER PROGRAM.

Economic Research Service, Washington, DC. Resources and Technology Div.

S. Piper, R. S. Magleby, and C. E. Young.

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-194385.

Price codes: A03 in paper copy, A01 in microfiche.

May 1989. 28 p, 3 fig, 8 tab, 60 ref.

Descriptors: \*Cost-benefit analysis, \*Project planning, \*Rural Clean Water Program, \*Rural areas, \*Water pollution prevention, \*Water quality, Agricultural runoff, Agriculture, Bacteria, Land use, Nursians Cost. Nutrients, Sediments, Water quality control, Water

Runoff from agricultural land carries sediment, nutrients, bacteria, and pesticides into lakes, rivers, and streams. Elevated levels of these pollutants can and streams. Elevated levels of these pollutants can harm recreation, water supplies, commercial fishing, and wildlife. The Rural Clean Water Program (RCWP) was initiated in 1980 by the US Department of Agriculture and the US EPA to demonstrate the effectiveness of agricultural best management practices (BMP's) in improving water quality and reducing the offsite effects of nonpoint source water pollution. The RCWP projects most likely to generate the highest offsite benefits are those aimed at preserving or improving water quality in a heavily used lake or estuary within or immediately adjacent to the project area. The extent of the benefits generated will depend on the level of the use impairment and the improvement in water quality. The RCWP projects with nutrient or bacteria problems frequently have a larger number of quality. The RCWP projects with nutrient or bacteria problems frequently have a larger number of impaired water uses and potentially higher benefits than do projects with sediment problems. The cost of treating bacteria, nutrients, and sediment with structural practices such as animal waste storage systems and terraces is high compared with the cost of treating sediment and nutrient runoff through low-cost management practices such as conservation tillage. When benefits are potentially very high, more expensive structural practices and conservation tillage. When benefits are potentially very high, more expensive structural practices and improvements appear justifiable, particularly if need to bring water quality to threshold levels where user benefits are generated. About a third of the RCWP projects have strong prospects for off-site economic benefits exceeding costs. Another third have the potential for positive net benefits if additional benefits can be generated by becoming part of larger regional programs that successfully sustain or expand uses of downstream major water presources. A few projects would have had better prospects for net benefits if costs had been reduced by greater reliance on management practices rather than structures such as terraces. (Lantz-PIT) W91\_02622

GUIDANCE MANUAL FOR COMPLIANCE WITH THE FILITRATION AND DISINFEC-TION REQUIREMENTS FOR PUBLIC WATER SYSTEMS USING SURFACE WATER SOURCES.

Pirnie (Malcolm), Inc., Paramus, NJ. For primary bibliographic entry see Field 5F. W91-02623

DRINKING WATER QUALITY STANDARDS AND STANDARD TESTS (JAN 72 - MAY 89). CITATIONS FROM THE FOOD SCIENCE AND TECHNOLOGY ABSTRACTS DATABASE. Davis (J.J.) Associates, Inc., McLean, VA. For primary bibliographic entry see Field 5F. W91-02646

HEAVY METALS IN DRINKING WATER: STANDARDS, SOURCES, AND EFFECTS (JAN 78 - SEP 89). CITATIONS FROM THE LIFE SCIENCES COLLECTION DATABASE. Davis (J.J.) Associates, Inc., McLean, VA. For primary bibliographic entry see Field 5F. W91-02647

CONTAINMENT OF ORGANIC LEACHATES FROM LEAKING UNDERGROUND STORAGE TANKS USING TAILORED SOILS AS LINERS.

TANKS USING TAILORED SOILS AS LINERS. Argonne National Lab., IL. Energy and Environmental Systems Div. R. W. Peters, F. Cadena, and M. W. Page. Available from the National Technical Information Service, Springfield, VA 22161, as DE89-013180. Price codes: AO3 in paper copy, AO1 in microfiche. 35 p. 10 fig. 4 tab, 28 ref. DOE Contract W-31100-Eps. 31-109-Fng-38

Descriptors: \*Liners, \*Soil liners, \*Storage tanks, \*Underground storage, \*Water pollution control, \*Water pollution prevention, Adsorption, Benzene, Clays, Model studies, Organic pollutants, Solute

The technical feasibility of using tailored soils for containment of hazardous organic pollutants has been demonstrated. The adsorptive properties of soils for benzene are dramatically improved using organophilic coatings. Tailoring of the soils results in a highly selective adsorbent, which has a great capacity to remove benzene, toluene, and xylene (BTX) compounds. All four soils studied showed significant adsorptive capacity improvement after tailoring with tetramethylammonium ions (TMA+). The optimum TMA+;CEC (cation exchange capacity) ratio was between 0.6 and 1.5 Soils tailored at TMA+ doses as low as 50% of the CEC of the soil removed significant amounts of benzene from solution. Ph plays a secondary role in the adsorption of benzene on the tailored soils. The capacities for benzene removal under dynamic column conditions were about 40-75% lower than those predicted from batch adsorption studies. The holdup of benzene increases with increasing clay content of the soils. The break-through curves for the pollutant movement through the soil columns can be predicted using conventional one-dimensional solute transport models. (Author's abstract)

SUPERFUND RECORD OF DECISION: TODTZ, LAWRENCE FARM, IA. FIRST REME-DIAL ACTION-FINAL.

nental Protection Agency, Washington,

DC. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-229553/AS. Price codes: AO4 in paper copy, AO1 in microfiche. Report No. EPA/ROD/R07-89/022. November 1988. 59p, 10 fig, 6 tab.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Iowa, \*Landfills, \*Site remediation, \*Superfund, Arsenic, Benzene, Chromium, Costs, Heavy metals, Lead, Toluene, Volatile organic

Compounds.

The 2.7-acre Dupont Impoundment of the Todtz Farm site is part of the 12-acre parcel of land known as the Todtz Farm Landfill, which is located on a 120-acre farm 1.25 miles west of Camanche, Iowa. Originally a sand and gravel mine, the landfill received municipal waste from 1969 to 1975. In 1971, Dupont constructed the impoundment in the northwest corner of the landfill and disposed of an estimated 4,300 tons of wet end cellophane process wastes from 1971 until its closure in 1975. Impoundment wastes are periodically in direct contact with the groundwater beneath the site, which flows southeasterly toward the Mississippi River. Domestic wells and the municipal water supply wells for Camanche located downgradient of the site may be affected by contamination from the site. In addition, several ponds and lakes in the vicinity are potential receptors for contaminated runoff and recharge. The primary contaminants of concern affecting the groundwater

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are volatile organic carbons (VOCs) including toluene and benzene, and metals including arsenic, lead, and chromium. The selected remedial action for this site includes installation of a soil cover for this site includes installation of a soil cover over the Dupont Impoundment; implementation of institutional controls including deed and land use restrictions; provision of an alternate water supply for an affected residence by relocating an existing well; and groundwater monitoring. EPA has determined that further remedial actions will be immediately implemented if groundwater trigger levels provided in the Record of Decision (ROD) are met or exceeded. If groundwater monitoring indicates that contaminant levels exceed the less stripcates that contaminant levels exceed the less strinchemical-specific action levels provided in gent chemical-specific action levels provided in the ROD, groundwater pumping and treatment will be implemented; if the more stringent action levels are exceeded, a treatability study of the impoundment waste will be conducted and either a permanent treatment remedy of the impoundment material or a cap and slurry wall containment system will be implemented. The estimated present worth cost for this remedial action is \$1,030,000. (Author's abstract) stract) W91-02649

IN-SITU AQUIFER RESTORATION OF CHLORINATED ALIPHATICS BY METHANO-TROPHIC BACTERIA.

TROPHIC BACTERIA: Stanford Univ., CA. Dept. of Civil Engineering. P. V. Roberts, L. Semprini, G. D. Hopkins, D. Grbic-Galic, and P. L. McCarty. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-219992/ AS. Price codes: All in paper copy, AOI in microfiche. Report No. EPA/600/2-89/033. July 1989. 232p, 123 fig, 43 tab, 166 ref.

Descriptors: \*Aliphatic hydrocarbons, \*Biodegra-Descriptors: "Anphane hydrocarbons, "Blodegradation, "Biological treatment, "Cleanup operations, "Groundwater pollution, "In situ treatment, "Methane, "Methane bacteria, "Water pollution treatment, Aerobic conditions, Biotransformation.

The potential of enhanced in-situ biotransforma-tion of chlorinated aliphatic solvents by a bacterial community grown on methane under aerobic con-ditions was examined. The target chlorinated com-pounds were trichloroethene (TCE), cis-, and trans -1,2-dichloroethene (DCE), and vinyl chloride (VC). Laboratory studies were conducted to im-prove understanding of the microbial growth and transformation rates and to characterize important transport properties. In field experiments, biostimutransport properties. In fleid experiments, biostimulation was accomplished by introducing methane and oxygen into a shallow, confined, sand and gravel aquifer to encourage the growth of a native bacterial community. Methane utilization commenced within ten days in the first biostimulation attempt, and within one day in subsequent biosti-mulation episodes. Biotransformation of the target organic compounds ensued immediately after comorganic compounds ensued immediately after com-mencement of methane utilization, and reached steady-state values within three weeks. The ap-proximate extents of transformation were as fol-lows: VC, 95%; trans-DCE, 85%; cis-DCE, 40%; and TCE, 20%. Mathematical modeling of the transport and transformation process confirmed that the behavior observed in the field demonstration was consistent with the results of the laborato ry research and theoretical expectations. This technology has been demonstrated to be effective in continuous operation under carefully controlled conditions in a real subsurface environment at small scale. (Author's abstract)

SUPERFUND RECORD OF DECISION: BERKS SAND PIT, PA. FIRST REMEDIAL ACTION-

Environmental Protection Agency, Washington,

Available from the National Technical Information Avanable to the National Technical International Service, Springfield, VA 22161, as PB89-206361/ AS. Price codes: AO3 in paper copy, AO1 in microfiche. Report No. EPA/ROD/R03-88/060. September 1988. 38p, 7 fig, 8 tab.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Site remediation, \*Superfund, \*Water pollution treatment, Costs, Pennsylvania, Volatile organic compounds, Water supply. The three to four-acre Berks Sand Pit site is located in Longswamp Township, Berks County, Penn-sylvania. There are at least 20 single family homes within the investigation area, including one on top of the actual sand pit. The immediate vicinity of the site is zoned for low density residential use. the site is zoned for low density residential use. The Berks Sand Pit was created by the removal of sand and gravel, but reportedly was used by area residents for refuse disposal. Industrial waste also was alleged to have been disposed of in the area around the pit. Houses were constructed and private wells installed at the location beginning in 1978, after the pit was backfilled. The site first came to the attention of EPA in January 1982. when area residents detected groundwater contamination. Emergency actions were undertaken by EPA in the summer of 1983. The pit was partially excavated and backfilled with clean fill, but no pocket of contamination was discovered. The primary contaminants of concern affecting the groundwater, surface water, and sediments are volatile organic carbons (VOCs) including 1,1,1-TCA, 1,1,-DCA, PCE, and 1,1-DCE. The selected remedial action for this site included: excavation of contaminated sediments with offsite treatment by contaminated sections in offsite treatment by incineration; groundwater pump and treatment using air stripping and vapor phase carbon absorption with reinjection of treated water back into the aquifer; provision of an alternate water supply system, surface and groundwater monitoring; and restrictions to prevent installation of drinking water wells in the contaminated aquifer. The estiwater weis in the contaminated aquifer. The esti-mated present worth cost for this remedy is \$10,773,100, with annual operating and mainte-nance costs of \$459,200. (Author's abstract) W91-02651

SUPERFUND RECORD OF DECISION: MO-TOROLA (52ND STREET PLANT), AZ. FIRST REMEDIAL ACTION.

Environmental Protection Agency, Washington,

Available from the National Technical Information Available from the National Technical Information Service, Springfield, VA 22161, as PB89-204861. Price codes: AO3 in paper copy, AO1 in micro-fiche. Report No. EPA/ROD/R09-88/024. Sep-tember 1988. 48p, 2 fig.

Descriptors: \*Arizona, \*Cleanup operations, \*Groundwater pollution, \*Organic solvents, \*Site remediation, \*Soil contamination, \*Superfund, \*Water pollution treatment, Costs, Phoenix, Scrubbers, Storage tanks, Trichloroethane, Underground

The Motorola 52nd Street site is located in the eastern part of the City of Phoenix, Maricopa County, Arizona. The site is bounded by the Phoenix Military Reservation and mixed residential and commercial neighborhoods. The site is currently commercial neighborhoods. The site is currently owned by Motorola, Ind., which operates a manufacturing facility at the site using solvents for various manufacturing processes. In January 1983, Motorola tested some underground storage tanks used to store virgin solvents for leaks and determined that a 5,000-gallon tank containing 1,1,1-trichloroethane (TCA) was leaking. Subsequently, Motorola conducted a preliminary investigation, which indicated soil and groundwater contamination off-the plant site and groundwater contamination offthe plant site and groundwater contamination offthe plant site and groundwater contamination offsite to the west. Motorola initiated an onsite groundwater treatment program in 1986, which included treatability testing, design and installation of a Pilot Treatment Plant (PTP), treatment of groundwater, and beneficial use of the effluent in he plant's air fume scrubbers. The PTP is still in operation. The selected remedy for this Record of Decision (ROD) requires partial cleanup of onsite and offsite organic solvents contamination in the soil and alluvium groundwater. As ubsequent remedial action will address cleanup of all onsite and offsite contamination in the soil, alluvium groundwater, and the bedrock underlying the alluvium. The primary contaminant of concern affecting the soil and groundwater is TCA. The selected remedial action for this site includes: onsite soil-gas extraction and treatment using granular activated carbon systems; pump and treatment of on-site and site to the west. Motorola initiated an onsite carbon systems; pump and treatment of on-site and off-site groundwater with treatment onsite and use of the treated groundwater in site manufacturing processes; and groundwater monitoring. The esti-mated present worth cost for this remedial action is \$7,600,000 with annual O&M costs of \$700,000. (Author's abstract) W91-02652

SUPERFUND RECORD OF DECISION: SELMA PRESSURE TREATING COMPANY, CA. FIRST REMEDIAL ACTION--FINAL. Environmental Protection Agency, Washington

DC. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-204853/AS. Price codes: AO6 in paper copy, AO1 in microfiche. Report No. EPA/ROD/RO9-88/025. September 1988. 123p, 5 fig, 2 tab.

Descriptors: \*California, \*Chemical wastes, \*Cleanup operations, \*Groundwater pollution, \*Site remediation, \*Soil contamination, \*Superfund, \*Water pollution treatment, Arsenic, Chromium, Costs, Dioxins, Heavy metals, Pentachloro-phonol Remediation measures phenol, Remediation measure

The Selma Pressure Treating Company is located in Selma, California, 15 miles south of the city of Fresno. The site encompasses approximately 18 acres, including a 3 to 4-acre wood treatment facility and 14 acres of adjacent vineyards that were used for site drainage. Land use in the vicinity of the site includes agricultural, residential and ty of the site includes agricultural, residential and industrial areas, with 12 residences and businesses located within 0.25 mile. The groundwater resources in the area have been classified as a Sole-Source Aquifer and a current drinking water source with other beneficial uses. Wood preserving activities using pentachlorophenol (PCP) were conducted at the site from 1942 until 1965 under a series of owners. In 1965, a new facility was structed converting operations to a pressure treat-ing process using chemical preservatives. Prior to 1982, wastes generated from spent retort fluids and sludges were discharged to drainage and percola-tion ditches, dry wells, and an unlined pond and sludge pit, as well as onto open ground and the adjacent vineyards. An inspection conducted by EPA in 1981 raised concerns about the potential for groundwater contamination, and as a result the company was required to modify its operations to minimize the potential for contamination. The total volume of soil requiring remediation is approximately 16,000 cu yds. The primary contaminants of mately 16,000 cu yds. The primary contaminants of concern affecting the groundwater and soil are organics including dioxin and phenols, and metals including arsenic and chromium. The selected remedial action for this site includes: groundwater pump and treatment using precipitation, coagulation, and flocculation with reinjection into the aquifer or offsite discharge; soil excavation and solidification/stabilization with replacement in excavated areas and capping fixed soil with RCRA cap; groundwater and soil monitoring for approximately 30 years; and long-term access and land use restrictions for fixed areas and short-term institutional controls for groundwater use. The estimated tional controls for groundwater use. The estimated present worth cost for this remedial action is \$11,280,000 with an annual operation and maintenance of \$1,300,000. (Author's abstract) W91-02654

SUPERFUND RECORD OF DECISION: CANNON ENGINEERING, MA. FIRST REME-DIAL ACTION--FINAL.

Environmental Protection Agency, Washington,

Available from the National Technical Information Avanabe Itolin de National Technica Information Service, Springfield, VA 22161, as PB89-225577/ AS. Price codes: All in paper copy, AOI in microfiche. Report No. EPA/ROD/R01-88/031. March 1988. 228p, 3 fig. 9 tab, 3 append.

Descriptors: \*Cleanup operations, \*Industrial wastes, \*Massachusetts, \*Site remediation, \*Sougerfund, Benzene, Costs, Monitoring, Polychlorinated biphenyls, Polycyclic aromatic hydrocarbons, Remediation measures, Storage tanks, Vinyl chloride, Volatile organic com-

The Cannon Engineering Corporation (CEC) facility is located in a small industrial park in the western part of the Town of Bridgewater, Plym-

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outh County, Massachusetts. The four-acre site is bordered by industrial developments to the north and east and a wooded lowland to the south and west. A wetland area lies south and west of the site. CEC, which has owned the property since 1974, handled, stored, and incinerated chemical waste onsite from 1974 to 1980. EPA conducted site investigations between 1980 and 1982, and in October 1982, Massachusetts contracted for the removal of sludge and liquid waste from onsite tanks and drums. In January 1988, EPA provided for the removal and disposal of numerous hazard-ous materials abandoned at the site. This remedial action addresses three discrete areas of soil and sediment contamination located in the northwestern and southern portions of the site, and the buildings, tanks, and other contaminated structures onsite. The volume of contaminated soil is estimated to be 325 cu yds. The primary contaminants of concern affecting the groundwater, soil, and debris are VOCs including benzene, TCE, and vinyl chloride, and other organics including PCBs and PAHs. The selected remedial action for this site includes: access restrictions; excavation and onsite treatment of VOC-contaminated soil by thermal aeration, and excavation and offsite treatment of PCB-contaminated soil by incineration; decontamination, removal, and disposal of contaminated buildings, tanks, and structures; additional soil sampling to assess effectiveness; groundwater monitoring program to assess antural attenuation of contaminants; and institutional controls to restrict onsite groundwater use. The estimated present worth operation and maintenance of \$700,000. (Author's abstract)

SUPERFUND RECORD OF DECISION: AVTEX FIBERS, VA. FIRST REMEDIAL ACTION.
Environmental Protection Agency, Washington,

DC. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-206197/AS. Price codes: AO5 in paper copy, AO1 in microfiche. Report No. EPA/ROD/R03-88/055. September 1988. 80p, 5 fig, 10 tab.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Industrial wastes, \*Site remediation, \*Superfund, \*Virginia, \*Water pollution treatment, Arsenic, Costs, Fly ash, Heavy metals, Lead, Phenols, Polyester, Polypropylene, Rayon, Remediation measures.

The 440-acre Avtex Fibers site is located in Warren County, Front Royal, Virginia. The facility is bounded to the west and northwest by the Shenandoah River and to the south, northwest, and east by residential areas. Approximately i,300 people live within one mile of the site. The western part of the site lies within the limits of the Shenandoah River's 100-year floodplain. The Avtex Fibers site has produced rayon fibers since 1940, polyester between 1970 and 1977, and polypropylene since 1985. During this 48-year period, byproducts from the rayon manufacturing process were disposed of in onsite surface impoundments. These byproducts included sodium cellulose xanthate-based viscose and zinc-hydroxide sludge. Fly ash (from incinerator exhaust air pollution control devices) and boiler house solids were disposed of in five other surface impoundments. Land disposal of viscose waste ceased in 1983; since that time, the waste has been routed directly to an onsite wastewater treatment plant. In 1982, carbon disulfade, a constituent of viscose waste, was identified in groundwater samples from residential wells located across the Shenandoah River from the site. In response to the results of a groundwater investigation Avtex implemented interim measures, which included purchasing 23 subdivision properties on the west side of the river that had contaminated domestic wells, and initiating a groundwater pump and treatment program. This Record of Decision (ROD) is the first of two operable units and addresses groundwater remediation and interim remedial measures for the viscose basins responsible for groundwater contamination. A subsequent remedial action will address source control and vis-

cose basin remediation. The primary contaminants of concern affecting the groundwater are phenols, and metals including arsenic and lead. The selected remedial action for this site includes: groundwater and basin liquid pump and treatment in the existing onsite activated sludge wastewater treatment plant, following completion of necessary upgrades, modifications, and construction of pretreatment units, with offsite discharge of treated water to the Shenandoah River; monitoring on-site and off-site groundwater, surface water, and basin fluids; and placing deed restrictions prohibiting the use of groundwater on the affected properties. The estimated present worth cost for this remedial action is \$9,122,000. (Author's abstract)

SUPERFUND RECORD OF DECISION: FINDETT, MO. FIRST REMEDIAL ACTION.
Environmental Protection Agency, Washington,

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-229538/ AS. Price codes: AO3 in paper copy, AO1 in microfiche. Report No. EPA/ROD/R07-89/023. December 1988. 43p, 8 fig, 3 tab.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Industrial wastes, \*Missouri, \*Site remediation, \*Soil contamination, \*Superfund, \*Water pollution treatment, Air stripping, Costs, Groundwater pumping, Polychlorinated biphenyls, Remediation measures, Volatile organic compounds.

The Findett/Hayford Bridge Road Groundwater site is located just north of the City of St. Charles, in St. Charles County, east-central Missouri. The site lies 3.2 miles south of the Mississippi River and is within the floodoplain. Land use in the site vicinity is primarily agriculture, but also includes a small industrial park containing Findett Corporation, Cadmus Corporation, and several other commercial and light industrial establishments. In addition, there are several residences within approximately 1,000 feet northeast and 1,500 feet south of the site. The Elm Point Wellfield, the primary drinking water supply for St. Charles, is located 1,800 feet northeast of the site. Until 1980, Findett Corporation reclaimed heat transfer fluids or oils, some of which contained PCBs, and received waste solvents for reclamation or recycling. Subsequently, Findett has custom blended or manufactured organic chemicals for other companies. The Findett site originally came to EPA's attention when Findett Corporation reported handling PCBs at the site. There is PCB-contaminated soil at the Findett facility as well as the adjacent Cadmus Corporation Facility. The Elm Point Well Field is also at risk of contamination by releases from the site. Findett conducted several voluntary PCB soil cleanups pursuant to EPA Administrative Orders in 1981 and 1982; however, PCBs as well as VOCs remain in the soil in concentrations above recommended levels. In addition, groundwater investigations revealed substantial VOC contamination in the shallow aquifer near the contamination under pCBs. The selected remedial action for this site includes onsite groundwater tupenjing and treatment using air stripping with discharge to the publicly owned treatment works (POTW); and accavation of contaminated soil with either offsite disposal or treatment. The estimated present worth cost for this remedial action is \$8,306,000 with an annual operation and maintenance cost of \$398,000. (Author's abstract)

SUPERFUND RECORD OF DECISION: SOUTH VALLEY/EDMUNDS STREET, NM. SECOND REMEDIAL ACTION.

Environmental Protection Agency, Washington,

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-225528/ AS. Price codes: AO3 in paper copy, AO1 in microfiche. Report No. EPA/ROD/R06-88/037.

June 1988. 47p, 3 fig, 2 tab.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Industrial wastes, \*New Mexico, \*Site remediation, \*Superfund, \*Water pollution treatment, Air stripping, Albuquerque, Costs, Groundwater pumping, Remediation measures, Volatile organic compounds.

water pumping, Remediation measures, Volatile organic compounds.

The South Valley/Edmunds Street site is a large area in the southern part of the City of Albuquerque, New Mexico, surrounding the municipal water well known as San Jose 6. Within this large area are a number of industrial properties owned and operated by different groups and individuals. This remedial action addresses the Edmunds Street Ground Water operable unit of the South Valley site; the Edmunds Street property is located in the southeastern corner of the site. The focus of this operable unit is the area around the monitoring well SV-10, referred to as the drainage pit area, on the Edmunds Street property. This area is the low spot of the property and receives much of the property drainage. Analyses of this area have shown significant levels of industrial solvents in the soil, and a plume of contaminated groundwater starting at the drainage pit area and extending to the east. The groundwater source will be treated as a sole-source aquifer because there are no alternate sources available to the City of Albuquerque. The contaminated groundwater currently poses a direct threat to Albuquerque's water supply by moving toward the city's well fields. The primary contaminants of concern affecting the groundwater include VOCs such as PCE and TCE. The selected remedial action for this site includes ground water pumping and treatment using air stripping (packed tower aeration) with reinjection of the treated water into the aquifer through infiltration galleries; and groundwater and air monitoring. The present worth cost for this remedial action is \$874,000, with present worth operation and maintenance costs estimated at \$280,000. (Author's abstract) W91-02658

SUPERFUND RECORD OF DECISION: COM-MENCEMENT BAY/NEAR SHORE, WA. FIRST REMEDIAL ACTION.

Environmental Protection Agency, Washington,

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-225544/ AS. Price codes: AO6 in paper copy, AO1 in microfiche. Report No. EPA/ROD/R10-88/011. December 1987. 109p, 8 fig, 5 tab, 3 append.

Descriptors: \*Cleanup operations, \*Coal gasification, \*Groundwater pollution, \*Industrial wastes, \*Site remediation, \*Soil contamination, \*Suserfund, \*Washington, Benzene, Costs, Lead, Monitoring, Polychlorinated biphenyls, Polycyclic aromatic hydrocarbons, Remedial measures.

The Tacoma Tar Pits site covers approximately 30 acres within the Commencement Bay-Nearshore/Tideflats site in Tacoma, Pierce County, Washington. The tar pits lie between the Puyallup River, the city, and Wheeler-Osgood Waterways. These bodies of water are not used as a water supply, but support extensive fish and shellfish populations. Currently there is concern for the site's impact on surface water quality and many local industries that use groundwater from onsite wells. In 1924, a coal gasification plant began operations, and continued until 1956, at which time they were terminated due to the availability of natural gas. During these years, waste materials from the coal gasification process were disposed of onsite. Contained in the waste materials, were a wide variety of organic compounds and heavy metals. From 1965 to 1966, the plant was dismantled and demolished. Most of the metal structures were removed from the site, however, all demolition debris and below grade structures were left in place, including tanks and pipelines containing tars. In 1967, a metal recycling company began operating at the site. Recycling of automobile batteries introduced acid, heavy metals, lead, and PCBs to the soil. Several studies conducted by EPA and the Washington State Department of Ecology between 1981 and 1988 found contaminants derived from the coal gasification

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process. The primary contaminants of concern affecting surface water and soil included: benzene, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls, and lead. The selected remedial action for this site includes: excavation of all contaminated soils exceeding 1% total PAHs and all surface soils exceeding a 0.000001 lifetime cancer risk level with stabilization of all excavated soils in a polymer/cement mixture; capping of the stabilized marrix with asphalt; channeling and managing of surface waters; groundwater monitoring; and removal and treatment of ponded water. The estimated present worth cost for this remedial action is \$3,400,000. (Author's abstract)

SUPERFUND RECORD OF DECISION: MASON COUNTY LANDFILL, MI, FIRST RE-MEDIAL ACTION.

Environmental Protection Agency, Washington,

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-206213/ AS. Price codes: AO6 in paper copy, AO1 in microfiche. Report No. EPA/ROD/R05-88/080. September 1988. 115p, 18 fig, 8 tab.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Industrial wastes, \*Michigan, \*Site remediation, \*Superfund, Aerators, Aquifers, Benzene, Costs, Gas vents, Landfills, Monitoring, Remediation measures, Volatile organic compounds, Xvlenes.

The Mason County Landfill site is located three miles south of the City of Ludington, Mason County, Michigan. The site occupies approximately 18 acres of a predominantly rural area in Pere Marquette Township. Approximately 10 acres of the site were used as a landfill. Less than 500 feet from the landfill there is a wetland area which drains into Babbin Pond, the headwaters of Iris Creek. There are 14 residential wells within a 0.5 mile radius of the landfill. The population within a 3-mile radius of the site is estimated to be 1,112. The Mason County Department of Public Works (DPW) leased the property in 1971 and entered into an agreement with Acme Disposal, Inc. to operate the site as a sanitary landfill. Although the Michigan Department of Natural Resources (MDNR) documented that slurry and sludge wastes from local industries were being dumped at the landfill, the site's license was renewed annually until it was closed in August 1978 after reaching capacity. Public concerns over the water quality in Iris Creek prompted the DPW and MDNR to review closure activities. In 1983, a clay cap was installed over the landfill and berms and storm from to facilitate biodegradation of organic matter and 15 gas vents were placed in the top of the landfill. The site has been separated into two operable units; one for the landfill contents and one for the groundwater. This source control remedial action afteressed in a subsequent remedial action. Site investigations indicate that contamination of surface water, surface sediment, soil, and offsite air quality are not sufficient to warrant remedial action. The primary contaminants of concern affecting the groundwater are VOC so including benzene, PCE, TCE, and xylene. The selected remedial action for this site includes: construction of a RCRA cap over the landfill; access restrictions; deed restrictions on and near the site to prohibit use of the shallow aquifer; and groundwater monitoring. The estimated present worth cost for this remedial action if St. 2800,000, with presen

SUPERFUND RECORD OF DECISION: UNITED NUCLEAR CORPORATION, NM. FIRST REMEDIAL ACTION.

Environmental Protection Agency, Washington,

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-206171/ AS. Price codes: AO7 in paper copy, AO1 in microfiche. Report No. EPA/ROD/R06-88/044. September 1988. 130p, 11 fig, 10 tab, 18 ref.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Mine wastes, \*New Mexico, \*Nuclear wastes, \*Site remediation, \*Superfund, \*Uranium, \*Water pollution treatment, Arsenic, Costs, Evaporation, Groundwater pumping, Metals, Monitoring, Radionuclides, Radium, Remediation measures.

The United Nuclear Corporation (UNC) site is located approximately 17 miles northeast of Gallup, New Mexico, in McKinley County. The site operated as a State-licensed uranium mill facility from June 1977 to May 1982. It includes an ore processing mill (about 25 acres) and an unlined tailings pond area (about 100 acres). The surrounding area is sparsely populated, with the nearest residence located 1.5 miles from the site. In July 1979, approximately 23 million gallons of tailings and pond water were released to a nearby river as a result of a dam breach in the tailings pond area. The site damage was repaired; however, attention was focused on groundwater contamination resulting from tailings seepage. Consequently, UNC implemented a groundwater pumping system that withdrew groundwater from the aquifers underlying the site and sent it to an onsite borrow pit for evaporation. UNC also conducted tailings neutralization from late 1979 to early 1982. Nevertheless, the offsite migration of radionuclides and chemical constituents from uranium milling byproduct materials into the groundwater, as well as to surface constituents from uranium milling byproduct materials into the groundwater, as well as to surface water and air, are still principal threats at the site. This remedial action will address onsite groundwater contamination. Source control and onsite surface reclamation will be implemented under the direction of the Nuclear Regulatory Commission and integrated with this groundwater operable unit. The primary contaminants of concern affecting the groundwater are metals including arsenic and radioactive substances including radium-226/228 and gross alpha. The selected remedial action of this site includes: implementation of a groundwater monitoring program to detect any increases in the areal extent or concentration of groundwater contaminated on the site includes: implementation of a proformance position of groundwater on a lovyear pump and treatment using existing and/or new extraction wells to control and remove

SUPERFUND RECORD OF DECISION: SOUTHERN MARYLAND WOOD, MD. FIRST REMEDIAL ACTION-FINAL.

Environmental Protection Agency, Washington,

DC. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-206387/AS. Price codes: AO5 in paper copy, AO1 in microfiche. Report No. EPA/ROD/RO3-88/051. June 1988. 85p, 5 fig, 15 tab.

Descriptors: \*Cleanup operations, \*Industrial wastes, \*Maryland, \*Site remediation, \*Superfund, \*Water pollution sources, \*Water pollution treatment, Activated carbon, Cylinder sludges, Groundwater pumping, Monitoring, Remediation measures, Retort sludges, Sedimentation, Surface water pumping, Volatile organic compounds.

The Southern Maryland Wood Treating (SMWT) site is located in Hollywood, St. Mary's County, Maryland. The site is situated within a wetland area in a drainage divide such that runoff from the site discharges into Brooks Run and McIntosh Run tributaries, which flow into the Potomac River. The area surrounding the site is predominantly used for agricultural and residential purposes. From 1965 to 1975, SMWT operated as a pressure treatment facility for wood preservation. Currently, part of the site is being used as a retail outlet for pretreated lumber and crab traps. The waste gener-

ated a the site included retort and cylinder sludges, process wastes, and material spillage. These wastes were in six onsite unlined lagoons. An onsite freshwater pond became contaminated during the facility's active and inactive periods with VOCs, polynuclear aromatics (PNAs), and base/neutral extractables due to contaminated groundwater and surface runoff. Cleanup actions were initiated in 1982 following legal actions by the Maryland Department of Health and Mental Hygiene. Liquids removed from the six lagoons were spray irrigated onto the nearby woods. The six lagoons were excavated, backfilled, and graded, and the freshwater pond was partially excavated. The excavated sludges were mixed with composited sludge and topsoil, and spread in a level treatment area located on the property. The primary contaminants of concern affecting the onsite groundwater soil, surface water, sediments, and debris include: VOCs, PNA, and base/neutral acid extractables. The selected remedial action for this site includes: excavation/dredging of soils, sediments, tank liquids, and cement, and treatment using onsite incineration with onsite disposal of non-hazardous residual ash, backfilling, regrading, and revegetating, where necessary; installation of a slurry wall; dewatering of the slurry wall area by a groundwater and surface water pumping system, and treatment using activated carbon adsorption or hydroen peroxide and irradiation with discharge to the onsite pond; installation of a geotextile silt fence, sedimentation basins, and/or diversion; and groundwater, surface water pumping system, and treatment using activated carbon adsorption or hydroen peroxide and irradiation with discharge to the onsite pond; installation of a geotextile silt fence, sedimentation basins, and/or diversion; and groundwater, surface water pumping system, and treatment vand and/or diversion; and groundwater, surface water promomental, organic vapor, and dust monitoring. (Author's abstract)

SUPERFUND RECORD OF DECISION: M.W. MANUFACTURING, PA. FIRST REMEDIAL ACTION.

Environmental Protection Agency, Washington,

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-229587/ AS. Price codes: AO4 in paper copy, AO1 in microfiche. Report No. EPA/ROD/R03-89/067. March 1989. 51p, 2 fig, 7 tab.

Descriptors: \*Cleanup operations, \*Copper, \*Groundwater pollution, \*Industrial wastes, \*Pennsylvania, \*Site remediation, \*Soil contamination, \*Superfund, Costs, Incineration, Lead, Remedial measures, Solvents, Volatile organic comrounds.

The M.W. Manufacturing site is a former copper recovery facility located in Montour County, Pennsylvania, two miles north of Danville. The Pennsylvania Department of Transportation (PennDOT) maintains a storage area immediately north of the site, and farmlands and wooded lots are adjacent to the site on the west and south. Mauses Creek flows in a southerly direction past the site. Several private residences, motels, gas stations, restaurants, and a Head Start School are located just north of the PennDOT storage area and rely on private groundwater wells for drinking water. M.W. Manufacturing was engaged in secondary copper recovery from scrap wire, using both mechanical and chemical processes. Granular carbon wastes generated by the chemical process were dumped onsite, and spent solvents and acids were allegedly disposed of onsite. In 1972, M.W. Manufacturing filed for bankruptcy and the Philadelphia National Bank acquired the property. Warehouse 81 Inc. acquired the site in 1976, and subsequently formed a limited partnership with Domino Salvage, Inc. to recover wire at the site using mechanical recovery only. The initial remedial investigation revealed several areas posing potential threats to public health: the carbon waste pile, four wire-fluff waste piles, a surface impoundment, buried lagoon and contaminated soils, drums and storage tanks. This remedial action addresses the concerns for direct contact with and migration to groundwater of contaminants from the carbon waste pile. The remaining areas are the subject of a long-term remedial investigation and feasibility study. The primary contaminants of concern affecting the soil are VOCs including PCE and TCE; organics including PCBs; and metals including lead. The selected remedial action for this site

includes excavating the carbon waste pile (approximately 875 cu yds of contaminated waste and contaminated underlying soils) and transporting the waste offsite to an incinerator facility and disposing of the ash in an offsite RCRA hazardous waste landfill. The estimated capital cost for this remedial action is \$2,061,000. Since onsite remediation activities are anticipated to require less than one year, there are no operation and maintenance costs (Author's abstract) costs. (Author's abstract) W91-02663

SUPERFUND RECORD OF DECISION: SOUTH VALLEY/SJ-6, NM. THIRD REMEDIAL ACTION.

al Protection Agency, Washington,

DC. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-204804/ AS. Price codes: AO4 in paper copy, AO1 in microfiche. Report No. EPA/ROD/R06-88/041. September 1988. 62p, 3 fig, 1 tab, 3 append.

Descriptors: "Cleanup operations, "Groundwater pollution, "Industrial wastes, "New Mexico, "Site remediation, "Soil contamination, "Superfund, Costs, Monitoring, Remediation measures, Solvents, Volatile organic compounds.

The South Valley/SJ-6 site is located on the southern margin of Albuquerque, New Mexico, just north of South Valley. The total site encompasses the SJ-6 municipal well, and six industrial facilities and their surrounding properties within an approximately one square mille radius. Land use is primarily industrial and agricultural with residential areas located immediately north of the site Industrial development began in the South Valley area just prior to the 1940s. Metal parts were manufactured in the area starting around 1948. By the 1960s, organic chemicals were being handled and packaged on the site. Currently, petroleum fuels and various chlorinated organics are stored, fuels and various chlorinated organics are stored, handled and used within the South Valley areas. handled and used within the South Valley areas. Groundwater contamination was first suspected in 1973 when foul tastes and odors were noted in groundwater from a private well on the Edmunds property in South Valley. Subsequent sampling revealed the presence of several VOCs in three municipal wells including 31-6. One of the wells was resampled in 1988 and found to be free of contaminants, another well was taken out of service because of mechanical problems, and SJ-6 was shut down in 1980 due to the continual detection of low levels of solvents. This Record of Decision (ROD) addresses only the source and extent of of low levels of solvents. This Record of Decision (ROD) addresses only the source and extent of groundwater contamination in the vicinity of JS-6. Principle threats at the site (i.e., the source and emanating plumes of contamination from surrounding areas) are being addressed through remedial actions initiated by EPA in separate RODs. The primary contaminants of concern affecting the groundwater are VOCs including 1,1-DCE, PCE and TCE. The selected remedial action for this site groundwater are VOCs including 1,1-DCE, PCE and TCE. The selected remedial action for this site includes: removal and disposal of 100 cu yds of contaminated sediments at the base of the SJ-6 borehole; sealing abandoned wells; groundwater monitoring; and access restrictions. The estimated present worth cost for this remedial action is \$4,000,000 with estimated an annual operation and maintenance of \$300,000. (Author's abstract) W91-02664

APPLICATION OF A SIMPLE SHORT-TERM BIOASSAY FOR THE IDENTIFICATION OF GENOTOXINS FROM HAZARDOUS WASTES. Environmental Health Research and Testing, Inc., Research Triangle Park, NC. For primary bibliographic entry see Field 5A. W91-02665

SUPERFUND RECORD OF DECISION: MID-DLETOWN AIR FIELD, PA.

DLETOWN AIR FIELD, PA.
Environmental Protection Agency, Washington,
DC. Office of Emergency and Remedial Response.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB89-211684/
AS. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/ROD/R03-88/039, December 1987. 47p, 3 fig, 9 tab.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Pennsylvania, \*Site remediation, \*Superfund, \*Volatile organic compounds, Air stripping, Costs, Drinking water, Groundwater pumping, Monitoring, Potable water, Remediation measures, Trichloroethene, Water pollution treatment.

The Middletown Air Field site covers what is now the Harrisburg International Airport (HIA), located between the town of Middletown and Nighspire, Dauphin County, Pennsylvania. The airport is owned and operated by the Commonwealth of Pennsylvania Department of Transportation. Thearea surrounding the base is characterized as mixed residential/industrial. Between 1898 and 1962, the property was owned by the U.S. Government and used by the military. HIA and several other entities occupy what was referred to as the Olmsted Air Force Base. In March 1983, trichlorethene (TCE) contamination caused six of the ten other entities occupy what was referred to as the Olmsted Air Force Base. In March 1983, trichloroethene (TCE) contamination caused six of the ten onsite production wells supplying HIA to be taken out of service. Studies initiated under the Department of Defense Installation Restoration Program indicate that while groundwater contamination due to volatile organic compounds exists, the exact source(s) of contamination cannot be clearly defined. Groundwater contamination may result from one or more, possible current, sources in the industrial area. To date, HIA has been able to temporarily meet the water requirements of the facility by taking the most contaminated well off-line as a potable water source, and by blending potable water from a number of wells. The most prevalent contaminants of concern affecting the groundwater are VOCs including TCE and PCE. The selected remedial action for this site includes: provision of a potable water supply; construction of a central treatment plant; groundwater pump and treatment using air stripping; and groundwater monitoring. The estimated capital cost for this remedial action is \$3,750,000 with annual operation and maintenance of \$160,000. (Author's abstract) W91-02669

GROUNDWATER MANAGEMENT: QUANTI-TY AND QUALITY.

For primary bibliographic entry see Field 4B. W91-02672

ROLE OF GROUNDWATER QUALITY IN THE DECISION-MAKING PROCESS FOR WATER RESOURCES

Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.

E. Custodio.
In: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 87-99, 19 ref.

Descriptors: \*Groundwater management, \*Groundwater pollution, \*Groundwater quality, \*Water pollution control, \*Water pollution sources, \*Water quality management, \*Water resources management, Aeration zone, Decision making, Forecasting, Groundwater movement, Monitoring, Saline water intrusion, Saturated zone.

The quality of aquifer water is a complex result of climatic, pedalogical, and lithological influences, modified by a set of interactions and reactions in the ground, both in the saturated and unsaturated the ground, both in the saturated and unsaturated zone. Many natural circumstances affect ground-water quality. Also man-induced changes in the flow system may alter it significantly, as is the case of seawater intrusion. Man's activities introduce an enormous variety of substances into the ground and this may lead to water contamination. The decision-making process has to consider these sources, the long transit times, the delayed and modified responses, and the difficulties involved in monitoring and forecasting. Prevention is generally more effective, feasible, and cheaper than repair and restoration. (See also W91-02672) (Author's abstract) abstract) W91-02680

MANAGEMENT OF GROUNDWATER-IN-DUCED RIVER SALINITY DUE TO LAND

### Water Quality Control-Group 5G

CLEARING IN THE MURRAY BASIN, SOUTH-EASTERN AUSTRALIA.

South Australian Dept. of Mines and Energy, Ade-

S. R. Barnett.

In: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 101-109, 5 fig, 1 tab, 8 ref.

\*Groundwater Descriptors: Descriptors: "Groundwater management, "Groundwater quality, "Irrigation effects, "Model studies, "Recharge, "Saline water, "Surface-groundwater relations, "Water pollution control, Australia, Computer models, Drainage equilibrium, Austraina, Computer models, Drainage equinorium, Groundwater pollution, Groundwater recharge, Land clearing, Murray River, River basin develop-ment, Saline groundwater, Vegetation effects, Vegetation regrowth, Water quality management, Water resources management, Water table rise.

Widespread clearing of native vegetation and ex-tensive irrigation in the Murray Basin in southeast-ern Australia has dramatically increased recharge remain a southeast-ern Australia has dramatically increased recharge and caused a major change to the hydrodynamic equilibrium of the basin. The resultant rising water table has caused widespread salinization with an estimated annual cost of \$100 million. Computer modeling has been used to estimate the effects on the salinity of the Murray River of the increase of saline groundwater discharge which will result from the rising water table. An increase of at least 70 EC units (70 microSiemen/cm) could occur 50 years after the water table begins to respond to the increased recharge. Selective broadscale revegeta-tion in critical areas adjacent to the river will reduce groundwater inflows by reducing recharge, but may prove uneconomic. (See also W91-02672) (Author's abstract) (Fish-PTT)

NITRATE IN GROUNDWATER.

Hanover Univ. (Germany, F.R.). Inst. fuer Wasser-wirtschaft, Hydrologie und Landwirtschaftlichen

For primary bibliographic entry see Field 5B.

HAZARDOUS WASTE CONTAINMENT USING CLAY LINERS.

Wayne State Univ., Detroit, MI. Dept. of Civil Engineering.

For primary bibliographic entry see Field 5E. W91-02690

STOCHASTIC CONTROL OF CONTAMINANT TRANSPORT PROBLEMS.

Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.

Hydraulic Lab.
R. Andricevic, and P. K. Kitanidis.
IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p. 271-284, 4 fig. 1 tab, 12 ref. National Science Foundation grants CEE-8420664 and ECE-8517598.

Descriptors: \*Groundwater movement, \*Hydro-Descriptors: "Groundwater movement, "Hydro-logic models, "Model studies, "Path of pollutants, "Site remediation, "Solute transport, "Water pollu-tion control, "Water pollution treatment, "Water quality management, Algorithms, Aquifers, Cost analysis, Mathematical models, Optimization, Para-metric hydrology, Pumping, Stochastic models, Uncertainty, Water resources management.

The design of effective remediation schemes is a major technological challenge. A major difficulty is the tremendous spatial variability in the soil properties in the geological environment in which these reactions take place. Geohydrological parameters, needed for the prediction of single-phase hydrological transport and fate of contaminants, often vary over orders of magnitude within the same site. In practice there is seldom enough information to specify with certainty all the parameters of the groundwater flow and transport system. An

## Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5G-Water Quality Control

optimization methodology to determine the most cost-effective pumping pattern and schedule has been developed which accounts for parameter uncertainty. It shows that, in an average sense, the cost consists of two parts: one which depends only on the best estimates and another which increases with the error in parameter estimation. A policy which minimizes the sum of the two parts was developed and applied to a simple case. Comparison with an optimization method which neglects uncertainty in parameter estimation determined the superiority of the proposed algorithm. The optimal policy may be one which focuses on reducing predictive uncertainty during the initial stages. It is reasonable that the more accurate the site characterization, the more cost-effective the remediation strategy which can be designed. On the other hand, in deciding how to reduce uncertainty, one must take into account how this will improve the decontamination effort. The major advantage of the methodology developed is that it selects the solution after weighing the estimation and the control objectives, and could be used for the 'optimal sampling' problem. (See also W91-02672) (Fish-W91-02696) PTT) W91-02696

MANAGEMENT MODEL FOR AQUIFER RECHARGE WITH NON-CONSERVATIVE POL-LUTANTS.

Baghdad Univ. (Iraq). Coll. of Engineering. For primary bibliographic entry see Field 4B. W91-02698

OPTIMAL GROUNDWATER QUALITY MAN-AGEMENT UNDER UNCERTAINTY: INCOR-PORATING THE EFFECTS OF SPATIAL VARI-ABILITY OF HYDRAULIC CONDUCTIVITY, Stanford Univ., CA. Dept. of Applied Earth Sci-

B. J. Wagner.
IIN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 419-430, 5 fig, 7 ref.

Descriptors: \*Groundwater management, \*Groundwater movement, \*Hydraulic conductivity, \*Hydrologic models, \*Model studies, \*Path of pollutants, \*Water pollution treatment, \*Water quality management, \*Water resources management, Augusters, Flow models, Groundwater pollution, Solute transport, Stochastic models.

In recent years, groundwater quality management models have been developed to aid the reclamation design process. These management models com-bine groundwater flow and contaminant transport simulation with optimization to design for the opti-mal remediation of contaminated aquifer systems. mal remediation of contaminated aquifer systems. Unfortunately, there are a number of potential sources of error associated with all groundwater flow and contaminant transport simulation models. Uncertainty due to spatial variability of hydraulic conductivity was explicitly incorporated into a procedure for the optimal design of aquifer remediation strategies. The management procedure is based on the stochastic approach to groundwater flow and contaminant transport modeling, in which the hydraulic conductivity is represented as which the hydraulic conductivity is represented as a random field. The remediation design procedure begins with the solution of the stochastic inverse model. Maximum Likelihood and Gaussian conditional mean estimation are used to characterize the random conductivity field based on hydraulic conrandom conductivity field based on hydraulic conductivity and hydraulic head measurements. Next, the nonlinear groundwater quality management problem is simultaneously solved for a sampling of hydraulic conductivity realizations. An example showed that reclamation design based on as few as thirty conductivity realizations can provide reliable remediation strategies. (See also W91-02672) (Author's abstract) (Author's abstract) W91-02708

FINITE ELEMENT COMBINED SURFACE WATER/GROUNDWATER MODEL FOR THE RIVER RHINE, KEHL/STRASBOURG RESER-

Lahmeyer International G.m.b.H., Frankfurt am Main (Germany, F.R.). W. Pelka, and R. Horst.

w. Pelsa, and r. Forst.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 523-532, 9 fig, 4 ref.

Descriptors: \*Dam design, \*Germany, \*Ground-water management, \*Ground-water resources, \*Model studies, \*Reservoir design, \*Rhine River, \*Surface-ground-water relations, \*Water resources management, \*Water supply development, Chan-nel flow, Cost analysis, Finite element method, Flow models, Ground-water level, River basins, Three-dimensional model, Watershed management.

River engineering measures in the Upper Rhine from Basel to Strasbourg (France and Germany) were completed by putting the River Strasbourg power plant into operation. To mitigate negative environmental effects and especially to maintain a certain water level in the original river bed to support the groundwater level, a barrage was constructed. To optimize the depth of diaphragm walls of the large retarding reservoirs upstream of the barrage, a mathematical model has been developed and implemented, combining a three-dimensional finite element groundwater flow model and a finite element channel flow model. The influence of the water level in the channels on the groundof the water level in the channels on the ground-water flow is introduced by leakage boundary conditions. The reference water level of the surface water results from the channel flow model. The parameters calibrated were permeability and leakage factors for the groundwater model and roughness for the channel flow model. To maintain roughness for the channel flow model. To maintain the required water level depth in the villages, for each diaphragm depth the cross-sections and slope of the drainage system had to be increased to a certain extent and several pump stations of varying capacity became necessary. For each diaphragm depth the costs of the expansion and correction of the drainage system were evaluated and compared with the costs of the related diaphragm wall. The with the costs of the related diaphragm wall. The optimum depth satisfying economic as well as environmental and safety requirements is about 20 m. For construction projects of this or similar dimension, the costs of even the most complicated and advanced numerical models are several orders of magnitude less than the costs which may arise without their application. (See also W91-02672) (Fish-PTT) W91-02716

ALLUVIAL AQUIFER OF THE GRAND GRA-VIER (RHONE VALLEY, FRANCE) MODEL-LING AND PROTECTION.

Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Lyon

A. Durbec, and C. Leduc. IN: Groundwater Many A. Durbec, and C. Leduc.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 581-593, 6 fig. 1 iab, 5 ref.

Descriptors: \*Aquifer management, \*France, \*Groundwater management, \*Groundwater resources, \*Lyon, \*Metropolitan water management, \*Potable water, \*Surface-groundwater relations, \*Water pollution prevention, \*Water resources management, \*Water supply development, Case studies, Environmental impact, Geohydrology, Grand Gravier Aquifer, Groundwater level, Groundwater movement, Groundwater recharge, Low flow, Model studies, Numerical analysis, Path of pollutants, River basins, Urban areas, Wells.

The water supply of the entire urban area of Lyon, The water supply of the entire urban area of Lyon, France, depends on groundwater. The heavy industrialization of the region generates a permanent risk of serious pollution. On the site of the Grand Gravier pumping station, especially representative of this context, a detailed hydrogeological study has allowed numerical modeling to be done of groundwater flow. Exchanges with the River Rhone have been quantified during low water flood. Direct recharge by the river exceeds 80%. Different solutions of hydraulic management have

been simulated and their impact on water catchment operations predicted. A numerical model of pollutant transport permits the efficiency of sanitary protection of well fields to be tested and points out the contamination risk. The regime of the Rhone banks is currently being studied. Using the efficient methodology drawn up on this aquifer, the relationships between the Rhone and its alluvium throughout the valley can be accurately determined. The resource vulnerability will be evaluated. On the entire basin scale, scientists and politicians have to provide information to predict and to face pollution accidents, where necessary, with suitable protection measures. (See also W91-02672) (Fish-PTT) W91-02721

DRINKING WATER CRITERIA DOCUMENT FOR TOLUENE.

Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-192298. Price codes: A12 in paper copy, A01 in microfiche. EPA Final Report ECAO-CIN-408, March 1987. 267p, 20 tab, 205 ref.

Descriptors: \*Drinking water, \*Regulations, \*Standards, \*Toluene, \*Water quality standards, \*Water treatment, Carcinogens, Classification, Organic solvents, Public health, Toxicity, Voiatile organic compounds.

Toluene is a relatively volatile organic solvent with a low water solubility, so that in aqueous solution it would be expected to evaporate into the environmental air. Because of its predisposition to environmental air. Because of its predisposition to exist as a vapor in the environment, most toluene exposure in humans is by inhalation. Absorption of toluene is rapid by inhalation or from the GI tract; absorption from the GI tract appears to be complete, while 50% of the inhaled toluene is absorbed through the lungs. In humans, the major effects of toluene are central nervous system dysfunction and narcosis. Applying EPA guidelines for the assessment of carcinogenic risk, toluene may be classified as group D: Not classified as to human carcinogenicity. This classification reflects the inadequate nature of the available data, thus preventing the development of a more definite statement regarding carcinogenic potential. The noncarcinothe development of a more definite statement re-garding carcinogenic potential. The noncarcino-genic effects of toluene in laboratory animals and humans have been utilized for derivation of health advisories and a drinking water equivalent level (DWEL). The 1-day health advisory value, based on a human 8-hr no-observed-adverse-effect level (NOAEL), is 18 mg/L for a 10 kg child. The proposed 10-day and longer term health advisory for a 10 kg child is 3 mg/L. The longer term health advisory for a 70 kg adult adopted the DWEL of 10 mg/L as a conservative estimate of exposure. The DWEL was derived from a NOAEL for male and female F344 rats exposed to toluene by inhalation at 300 ppm for 106 wks. The toluene by inhalation at 300 ppm for 106 wks. The resultant DWEL for toluene is 10 mg/L. (Lantz-W91-02731

DRINKING WATER CRITERIA DOCUMENT FOR 2(2,4,5-TRICHLOROPHENOXY) PROPI-ONIC ACID (2,4,5-TP).

Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment

Office.

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-192330. Price codes: A07 in paper copy, A01 in microfiche. EPA Final Report ECAO-CIN-419, September 1987. 132p, 14 tab, 120 ref.

Descriptors: \*Drinking water, \*Halogenated pesticides, \*Herbicides, \*Regulations, \*Silvex, \*Water quality standards, \*Water treatment, Carcinogens, Organic acids, Public health, Standards, Toxicity, Water quality control.

2,4,5-Trichlorophenoxypropionic acid (2,4,5-TO), Silvex, is a commonly used systemic herbicide for both agricultural and nonagricultural purposes.

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The commercial herbicide is contaminated with 2,3,7,8-TCDD, a highly toxic tetra-chlorinated dibenzo-p-dioxin. Human studies have shown some positive evidence that exposure to phenoxy herbicides together with 2,3,7,8-TCDD as a contaminant correlates with an increase in soft tissue sarcomas and non-Hodgkins lymphomas. The EPA has given this mixture of compounds a BI weight-of-evidence ranking, which indicates that this mixture is probably carcinogenic for humans. Neither 2,4,5-TP nor 2,3,7,8-TCDD alone can, be shown to have this carcinogenic potential, however. The quantificarcinogenic potential, however. The quantifi-on of toxicological effects of 2.4.5-TP involved cation of toxicological effects of 2,4,5-TP involved the identification of doses at which adverse health effects are anticipated for both chronic and acute exposures in adults and children consuming 2 L or 1 L water/day. The 10-day health advisory of 0.2 mg/L (1.4 mg/day) was derived for a child exposed to 2,4,5-TP in water. A drinking water equivalent level (DWEL) of 0.26 mg/L was derived for lifetime exposure for an adult. The EPA has taken similficant regulatory action on 2 A 5-TP has taken similficant regulatory action on 2 A 5-TP. rived for lifetime exposure for an adult. The EPA has taken significant regulatory action on 2,4,5-TP as an herbicide product. As of February 1987, the result of the actions taken should be to reduce the availability of 2,4,5-TP, and hence its discharge into the environment, to virtually a nil level. The exception to this would be a situation where the storage of 2,4,5-TP in controlled or uncontrolled dump sites on solved the constrict world in a storage of 2,4,5-TP in controlled or uncontrolled dump sites or related scenarios might result in a discharge to the environment. The regulatory action against herbicide uses began in February 1979 when 2,4,5-TP use in forestry, rights of way, pasture, home and garden, and ornamental gardening was suspended. Between 1979 and February 1985 all other registrations for 2,4,5-TP uses were cancelled by the US EPA. From February 1985 through February 1986, existing 2,4,5-TP stockpiles only were allowed into commerce only for highly limited use. As of February 1986 all sales of 2,4,5-TP ceased. (Lantz-PTT) W91-02732

DRINKING WATER CRITERIA DOCUMENT FOR TOXAPHENE.

Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment Office

Office.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-192306. Price codes: A07 in paper copy, A01 in microfiche. EPA Report ECAO-CIN-426, February 1987. 128p, 29 tab, 216 ref.

Descriptors: \*Carcinogens, \*Drinking water, \*Halogenated pesticides, \*Regulations, \*Standards, \*Toxaphenes, \*Water quality standards, \*Water treatment, DDT, Insecticides, Lethal limit, Organic compounds, Public health, Toxicity.

Toxaphene is a broad spectrum, chlorinated ter-penoid pesticide introduced in the US as a contact insecticide in 1948. Together with methoxychlor, toxaphene has be-n the chief replacement for DDT when the use of DDT was banned. A varie-ty of guidelines or standards have been published by of guidelines or standards have been published to protect against toxaphene in aquatic media. That national interim primary drinking water standard is 5 microgm/L. The FDA mandated level for bottled water is also 5 microgram/L. These standards are based upon organoleptic effects. The water quality criterion for the protection of human health was originally set at 0.5 microgram/L for a 0.0001 cancer risk level. This criterion was subsequently revised to 7.1 ng/L for a risk of 0.0001. If consumption of aquatic organisms is considered alone, the corresponding risk level is 7.3 ng/L. Toxaphene has caused convulsions and nausea in humans when exposure has occurred by ingestion, skin contact or inhalation. The acute oral LD50, estimated from accidental poisonings was found to vary between 29 and 100 mg toxaphene/kg body weight. Mixtures of toxaphene with DDT (2:1, by weight) are more acutely toxic than either component alone. The recommended criterion for chronic exposure to toxaphene in drinking water, not ic exposure to toxaphene in drinking water, not considering intake from other sources, is 3.1, 0.31 and 0.031 micrograms/L to maintain individual cancer risk less than 0.0001, 0.00001, and 0.000001, respectively. The sufficient level of carcinogenic evidence in experimental animals, together with the inadequate level of human evidence meets the IARC Group 2B criteria for weight of evidence

that a chemical is likely to be a human carcinogen. The assignment of a Group 2B designation by IARC means that the chemical is probably carcinogenic in humans. (Lantz-PTT) W91-02733

APPLICATION OF DIRECT PLAQUE ASSAY FOR DETECTION AND ENUMERATION OF BACTERIOPHAGES OF BACTEROIDES FRA-GILIS FROM CONTAMINATED-WATER SAM-

Malaga Univ. (Spain). Dept. of Microbiology. For primary bibliographic entry see Field 5A. W91-02770

SECONDARY DISINFECTION OF SERVICE

RESERVOIRS. Yorkshire Water Authority (England). Western For primary bibliographic entry see Field 5F. W91-02846

LOW FLOW ESTIMATION BASED ON RIVER RECESSION RATE. Clyde River Purification Board, East Kilbride

(Scotland). For primary bibliographic entry see Field 2E. W91-02847

EC BATHING WATERS DIRECTIVE AS AP-PLIED TO SCOTLAND.

Forth River Purification Board, Edinburgh (Scot-

M. Halcrow, and T. M. Leatherland.

Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 4, p 356-360, August 1990. 3 tab, 7 ref.

Descriptors: \*Bacteria, \*Recreation, \*Regulations, \*Scotland, \*Swimming, \*Wastewater disposal, \*Water quality, Coliforms, Monitoring, Ocean dumping, Outfall sewers, Standards, Wastewater outfall, Wastewater pollution, Water quality con-

Monitoring of the bacteriological quality of potential bathing waters has been carried out in Scotland since the publication of the EC bathing waters Directive 14 years ago. However, it has only been since 1987 that 23 beaches in Scotland have been since 1987 that 23 beaches in Scotland have been officially recognized as having bathing waters which should meet the environmental quality standards (EQS) laid down by the Directive. Results of the first three years' monitoring are outlined and the cost of this work has been estimated. Treatment of effluents through solids removal, trade effluent control at source, and dispersion from a long sea outfall is the most appropriate form of sewage disposal in the majority of coastal situations. All future coastal sewage disposal schemes should be sited so as to make provisions for additional works to meet possible new standards. The need to monitor both indicator and target organisms is questioned, and studies are cited suggesting that the present mandatory coliform standards may not be sufficiently stringent. (Lantz-TTT) (Lantz-PTT) W91-02848

SLUDGE DISPOSAL STRATEGY FOR DUM-FRIES AND GALLOWAY REGIONAL COUN-

For primary bibliographic entry see Field 5E. W91-02850

EUROPEAN ENVIRONMENTAL DIRECTIVES-IMPLICATIONS FOR NORTHERN IRELAND.

D. R. Savine.

Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 4, p 379-385, August 1990. 9 tab, 8 ref.

Descriptors: \*Economic aspects, \*Northern Ireland, \*Regulations, \*Waste disposal, \*Water quality, Compliance, Drinking water, Municipal wastewater, Ocean dumping, Outfall sewers,

Recreation, Swimming, Wastewater outfall, Wastewater treatment, Water quality control.

The current level of compliance in Northern Ireland with the European Community (EC) Directives on drinking water quality, bathing water quality, sewage sludge to land and the draft Directive on the disposal of sewage sludge to the sea, is discussed. The cost implications of full compliance are examined, taking account of works already programmed, and concluding that additional funding will be required over the next ten years amounting to almost 250 million pounds. A large portion of this sum will be required for improvements relating to the drinking water directive. Compliance with the Directives are compulsory. A describition of the increase in estimated additional The current level of compliance in Northern Iredescription of the increase in estimated additional funding to approximately 440 million pounds, due to general inflation and other factors, is included. These other factors include: the new draft municipations of the control of th anise one incrors include: the new draft municipal wastewater treatment Directive, together with the March 1990 announcement by the UK Environment Minister committing the UK to the cessation of sewage sludge dumping at sea, and the provisions of sewage treatment for coastal outfalls. (Author's abstract)

DIVERSION CAPACITY OF CAPILLARY BAR-

Disposal Safety, Inc., Washington, DC.
For primary bibliographic entry see Field 5E.
W91-02887

LACK OF THEORETICAL BASIS FOR PRE-DICTING RATE AND PATHWAYS OF RECOV-ERY.

Virginia Polytechnic Inst. and State Univ., Blacks-burg. Center for Environmental and Hazardous Material Studies. J. Cairns.

Environmental Management EMNGDC, Vol. 14, No. 5, p 517-526, 1990. 1 tab, 32 ref.

Descriptors: \*Habitat restoration, \*Lotic environ-ment, \*Rehabilitation, \*Stream improvement, \*Water pollution treatment, Ecology, Ecosystems, Prediction, Running waters, Theoretical analysis.

An inadequate basis for precisely predicting the outcome of lotic ecosystem recovery, whether due to unaided natural processes or management techniques or both, exists because: (1) the field of ecology has not yet matured as a rigorous predictive science; (2) the precise sequence of events, including climatic occurrences, affecting the recovery process, may be unique events and thus ocovery process may be unique events and thus rarely or never repeated; and (3) even when attempts are made to control the recolonization process through introduction of species and such the interaction of these species may not follow deterministic models. Lotic ecosystems are infludeterministic models. Lotic ecosystems are influenced strongly by exports from the surrounding land mass and, under certain circumstances, this may be the overriding influence on the recovery process. Therefore, unless the boundary conditions are determined realistically, the recovery process may not follow desirable pathways. Despite the lack of a robust theoretical support base for lotic ecosystem recovery, some remarkable and rapid recoveries have occurred to either a close approximation of the original condition or to a condition. In some cases, the recovery was due entirely to natural processes and often followed relatively straightforward management practices. There is evidence ral processes and other followed relatively straight-forward management practices. There is evidence indicating that lotic ecosystem restoration is both cost-effective and likely to produce satisfying re-sults fairly rapidly. It is both fortunate that this is the case, since society is likely to support such efforts when the results have been extraordinarily successful, and unfortunate since restoration ecology needs a predictive capability. (Author's abstract) W91-02895

INDICATORS OF ECOSYSTEM RECOVERY. Cornell Univ., Ithaca, NY. Ecosystems Research

#### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5G-Water Quality Control

J. R. Kelly, and M. A. Harwell. Environmental Management EMNGDC, Vol. 14, No. 5, p 527-545, 1990. 5 fig. 4 tab, 46 ref. Cornell University and EPA Cooperative Agreement No. CR81268501.

Descriptors: \*Bioindicators, \*Ecosystems, \*Lotic environment, \*Monitoring, \*Rehabilitation, \*Stream improvement, \*Surveys, Data acquisition, Ecological effects, Streams, Stress

The assessment of ecological changes relative to disturbance, either natural or human induced, confronts a fundamental problem. Ecosystems are complex, variable and diverse in nature; consequently, the need for simplification to essential features that would characterize ecosystems adequately, is generally acknowledged. Yet there is no firm prescription for what to measure in order to describe the response and recovery of ecosystems to stress. Initial focus is provided by identifying relevant ecological endpoints, such as ecological changes of particular relevance to humans. Furthermore, it is suggested that generic purposes and criteria be considered when making choices for ecological indicators that relate to those endpoints, such Sultes of indicators, with a variety of purposes, are Suites of indicators, with a variety of purposes, are required to assess response and recovery of most ecosystems and most stresses. Measures of certain system processes may provide special insight the early stages of recovery; the use of functional indicators as complimentary to other biotic indicators is highlighted in an extended example for lotic ecosystems. (Author's abstract) W91-02896

RECOVERY OF LOTIC COMMUNITIES AND ECOSYSTEMS FROM DISTURBANCE-A NAR-RATIVE REVIEW OF CASE STUDIES.

Environmental Research Lab., Duluth, MN. J. D. Yount, and G. J. Niemi. Environmental Management EMNGDC, Vol. 14, No. 5, p 547-569, 1990. 170 ref.

Descriptors: \*Case studies, \*Ecosystems, \*Habitat restoration, \*Lotic environment, \*Rehabilitation, \*Stream improvement, Ecological effects, Flushing, Life history studies, Literature review, Restoration, Stream biota, Water quality.

A narrative account is given of case studies of the recovery of flowing water systems from disturbance, focusing on conclusions about recovery time and the factors contributing to recovery. Attention is restricted to case studies in which the recovery of some biological property of the system has been examined, excluding those that deal only with physical or chemical properties. Although natural processes and rates of recovery are emphasized, studies of restoration or reclamation of damaged studies of restoration or reclamation of damaged ecosystems are included where they contribute to studies of restoration or reclamation of damaged ecosystems are included where they contribute to an understanding of recovery processes. For the majority of studies examined, the systems recovered quite rapidly. The most commonly cited reasons for short recovery times were: (1) life history characteristics that allowed rapid recolonization and repopulation of the affected areas; (2) the availability and accessibility of unaffected upstream and downstream areas and internal refugia to serve as sources of organisms for repopulation; (3) the high flushing rates of lotic systems that allowed them to quickly dilute or replace polluted waters; and (4) the fact that lotic systems are naturally subjected to a variety of disturbances and the biota have evolved life history characteristics that favor flexibility or adaptability. In general, longer recovery times were observed in disturbances, such as channelization, that resulted in alterations to physical conditions. This review also indicates that much of the knowledge of recovery in lotic ecosystems is fragmented and uncoordinated. In addition to establishing the bounds of recovery time, this review identifies some research gaps that need to be filled. (Author's abstract) W91-02897

OVERVIEW OF CASE STUDIES ON RECOVERY OF AQUATIC SYSTEMS FROM DISTURBANCE.

ota Univ.-Duluth. Natural Resources Re-

G. J. Niemi, P. DeVore, N. Detenbeck, D. Taylor,

and A. Lima.
Environmental Management EMNGDC, Vol. 14, No. 5, p 571-587, 1990. 9 fig, 14 tab, 39 ref.

Descriptors: "Aquatic environment, "Case studies, "Ecosystems, "Habitat restoration, "Rehabilitation, "Stream biota, "Water pollution effects, DDT, Ecological effects, Fish, Literature review, Lotic environment, Macrophytes, Periphyton, Phytoplankton, Streams, Stress, Water quality.

An extensive review of the published literature identified more than 150 case studies in which some aspect of resilience in freshwater systems was reported. Approximately 79% of systems studied were lotic and the remainder lentic. Most of the stressor types were chemical with DDT (N = 29) and revene (N = 15) the resilience. stressor types were chemical with DDT (N=29) and rotenone (N=15) the most common. The most common nonchemical stressors were logging activity (N=16), flooding (N=8), dredging (N=3), and drought (N=7). The variety of endpoints to which recovery could be measured ranged from sparse data for phytoplankton (N=13), periphyton (N=6), and macrophytes (N=8), to relatively more data for fish (N=412) and macroinvertabrates (N=698). Unfortunately the same characteristics were rarely measured consists. macroinvertabrates (N = 698). Unfortunately the same characteristics were rarely measured consistently among sites. For example, with respect to fish, more than 30 different species were studied and recovery was measured in many ways, most commonly on the basis of: (1) first reappearance of the species, (2) return time of predisturbance densities, and (3) return time of predisturbance average of individual size. Based on these criteria, all systems in these studies seem to be resilient to most disturbances with more tracevery times being less tems in these studies seem to be resilient to most disturbances with most recovery times being less than 3 years. Exceptions included when: (1) the disturbance resulted in physical alteration of the existing habitat; (2) residual pollutants remained in the system; or (3) the system was isolated and recolonization was suppressed. (Author's abstract) W91-02898

APPLIED LAND CLASSIFICATION FOR SURFACE WATER QUALITY MANAGEMENT: I. WATERSHED CLASSIFICATION.
National Chunghsing Univ., Taichung (Taiwan).
Graduate Inst. of Urban Planning.
S. L. Huang, and J. J. Ferng.
Journal of Environmental Management JEVMAW, Vol. 31, No. 2, p 107-126, September 1990. 4 fig, 8 tab, 33 ref. National Science Council, Executive Yuan of the Republic of China (Grant No. NSC77-0301-H005-03Z).

Descriptors: \*Land classification, \*Land use, \*Taiwan, \*Water quality management, Classification, Land management, Model studies, Multivariate analysis, Spatial distribution, Water pollution effects, Watersheds.

A land classification scheme for water quality management was developed for the Tanshui River Basin, Taiwan, using the watershed as the basis for classification. Seventy-eight third order watersheds were grouped into five watershed zones representing varied assimilative capacities and relative societal properties of water quality management. Multivariate techniques (factor analysis, cluster analysis, and discriminant analysis) were used for this purpose. The results indicate that the detection of spatial natterns having ecological significance is purpose. The results indicate that the detection of spatial patterns having ecological significance is possible through multivariate techniques. Also, the assimilative capacity and potential effects of pollu-tion due to inadequate land measurement can be assessed through the incorporation of watershed assessed through the incorporation of watersned characteristics such as topography, soil, land cover, etc. The significance of this study is its potential usefulness for integrating land and water quality management. (See also W91-02948) (Medina-PTT)
W91-02947

APPLIED LAND CLASSIFICATION FOR SUR-APPLIED LAND CLASSIFICATION FOR SUR-FACE WATER QUALITY MANAGEMENT: II. LAND PROCESS CLASSIFICATION. National Chunghsing Univ., Taichung (Taiwan). Graduate Inst. of Urban Planning.

S. L. Huang, and J. J. Ferng.
Journal of Environme Management

JEVMAW, Vol. 31, No. 2, p 127-141, September 1990, 6 fig, 2 tab, 21 ref. National Science Council, Executive Yuan of the Republic of China (Grant No. NSC77-0301-H005-03Z).

Descriptors: \*Land classification, \*Numerical analysis, \*Taiwan, \*Water pollution sources, \*Water quality management, Classification, Land management, Land use, Soil erosion, Surface runoff, water, Watersheds

A land process classification system was developed through assessment of sensitive areas for management of water quality in the Tanshui River Basin, Taiwan. A grid approach was used to identify environmentally sensitive areas for the control of non-point sources of pollution. Surface runoff, surenvironmentatily sensitive areas for the control of mon-point sources of pollution. Surface runoff, surface erosion, and distance to stream were used as variable inputs for taxonomic classification. Using a numerical approach, the Tanshui River Basin was divided into four land classes which represented various sensitivities of land resource effects on water quality. The approach and results demonstrated in this study refined the spatial variation of land characteristics within a classified watershed area and also revealed the interrelationships between watershed characteristics and water quality through land process responses. The classification scheme can serve as a basis for local land use control to minimize adverse effects on surface water resulting from incompatible land uses and inadequate land management practices. Land use performance can also be established according to the sensitive characteristics of each class zone. (See also W91-02947) (Medina-PTT)

### STATE OF THE CHESAPEAKE BAY.

G. B. Mackiernan.

Water Environment & Technology WAETEJ, Vol. 2, No. 9, p 60-67, September 1990. 4 fig.

Descriptors: \*Administrative agencies, \*Aquatic habitats, \*Chesapeake Bay, \*Ecosystems, \*Estuaries, \*Water pollution, \*Water resources management, Algal growth, Anadromous fish, Anaus, Bays, Biomass, Degradation, Governmental interrelations, Hydrocarbons, Submerged plants, Trace metals, Wastewater disposal.

Chesapeake Bay, the largest estuary in the USA, is a system under threat as a result of population growth and development in the area, alteration of habitats, and discharge of pollutants. Prompted by public concern, the U.S. Environmental Protection Agency (EPA) undertook a study of this troubled estuary in 1977. In 1983, the EPA released reports of widespread ecosystem degradation and warned that trends would continue as development increased unless effective management actions were implemented. The reports concluded that much of the bay was overenriched with nitrogen and phosphorus; levels of chlorophyll a found in algal biomass were increasing in most regions; the volume of water exhibiting hypoxia or anoxia had increased significantly in the preceding 30 years; elevated levels of trace metals and polyaromatic hydrocarbons were present in water, sediments elevated levels of trace metals and polyaromatic hydrocarbons were present in water, sediments and in the tissue of bay organisms; there had been an unprecedented bay-wide loss of submerged vegetation; landings of anadromous finfish and oysters had declined significantly; and there were accompanying failures of recruitment in many species. These findings and subsequent recommendations led to the establishment of a federal and state Chesapeake Bay Restoration Program, linking Maryland, Virginia, Pennsylvania, and the District of Columbia in an effort to improve and protect the water quality and living resources of the the water quality and living resources of the Chesapeake Bay estuarine system. The initial agreement in 1983 outlined actions to reduce nutrient input, control toxic materials, and to enhance ent input, control toxic materials, and to enhance bay species and their habitats. A cooperative bay-wide monitoring program was also initiated to evaluate environmental trends and to track progress. In 1987, specific commitments and deadlines were established including a basin-wide 40% reduction of both P and N from both point and nonpoint sources by the year 2000; reduction of inputs of toxicants bay-wide, consistent with the 1987 Water Quality Act; and restoration, protec-

# **Evaluation Process—Group 6B**

tion, and enhancement of fishery resources and habitats. (Medina-PTT) W91-02956

TWO DECADES OF PROGRESS.

IWU DECALDES OF PROGRESS.
Fairfax County Dept. of Public Works, Lorton,
VA. Wastewater Treatment Div.
A. Hogge, and R. Soltis.
Water Environment & Technology WAETEJ,
Vol. 2, No. 9, p 68-71, 234-235, 237, September
1990. 2 tab.

Descriptors: \*District of Columbia, \*Potomac River, \*Virginia, \*Wastewater facilities, \*Wastewater treatment, \*Water pollution control, \*Water pollution sources, \*Water quality, Administrative agencies, Algal blooms, Bacterial analysis, Human diseases, Sport fishing, Vegetation regrowth, Wastewater disposal, Water quality standards

Rapid development and population surge in the Washington D.C. area in recent years have caused increased water-quality degradation in the Potomac River, one of the areas's major water bodies. Due to elevated bacterial levels and the danger of catching water-borne diseases, the U.S. Public Health Service, as early as 1925, declared the Potomac River unsafe for swimming. The greatest water-quality concerns were centered on the section of the Potomac Riowing through the metropolitan area which receives the greatest volume of regional wastewater discharges. This caused noxious algae blooms, high bacterial counts, and very low dissolved oxygen (DO), noticeable during the summer months. However, today, the low DO levels have essentially disappeared, and submerged vegetation has reappeared and spread, reflecting the tremendous progress made during the mid 1970s and 1980s. Recreational fishing has returned and summer bacterial levels have begun to approximate the contract of the cont 19/0s and 1980s. Recreational inshing has returned and summer bacterial levels have begun to approx-imate the established water-quality standards. Peri-odic violations of bacterial standards occur be-cause of untreated combined sewer outflows and cause or untreated combined sewer outflows and nonpoint source runoff during heavy rains. An estimate is also given for the operational cost and upgrading of these Virginia treatment plants by the year 2000. (Medina-PTT) W91-02957

### 6. WATER RESOURCES PLANNING

### 6A. Techniques Of Planning

ANALYSIS BY FUNCTIONS APPLIED TO HY-DROMETRY (L'ANALYSE PAR FONCTIONS APPLICATION A 'HYDROMETRIE). Agence Financiere de Bassin Seine-Normandie, Paris (France). For primary bibliographic entry see Field 7C. W91-02050

IMPROVED METHODS FOR REGIONAL FLOOD FREQUENCY ANALYSIS, Colorado State Univ., Fort Collins. Dept. of Civil

Engineering.
For primary bibliographic entry see Field 2E.
W91-02243

MISSOURI RIVER MANAGEMENT PROJECT: LEARNING TO COOPERATE.

IN: Indian Water Rights and Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1989. p 11-19.

Descriptors: \*Governmental interrelations, \*Indian water rights, \*Missouri River, \*Regional planning, \*Water resources management, \*Water rights, \*Water use, Competing use, Federal jurisdiction, Indian reservations, Riparian rights, State jurisdic-

This century has brought phenomenal change to the Missouri River. Six mainstem dams, operated

by the Army Corps of Engineers, have been con-structed in its upper reaches for flood control and structed in its upper reaches for flood control and commercial navigation. Other than the annual adoption of an operating plan by the Corp of Engineers, there is little attempt being made by the basins citizens, Indian tribes, states and federal government, to coordinate and plan for the basin's future. Basin water allocation issues which involve Indian research twater in other and industrial and the control an Ituture. Basin water allocation issues which involve Indian reserved water rights and industrial marketing of water, have made their way to the US Supreme Court twice in the last two years. The dearth of the Missouri River Basin coordination and planning has motivated the Northern Lights Institute, located in Montana, to initiate in 1985, the Missouri River Management Project. This recipiet now in its fourth was easier to democrate. the Missouri River Management Project. This project, now in its fourth year, seeks to democratically involve the basin's three sovereigns and its citizenry in a cooperative approach to reshape river management policies to reflect contemporary public values in a manner that is compatible with the riparian environment. Through this project, it has been found that the fundamental deterrent to sound water management in the Missouri River Basin is a lack of trust and cooperation. (See also W91-02262) (Lantz-PTT) W91-02264

INDIAN WATER RIGHTS SETTLEMENTS: THE ROLE OF LOCAL REPAYMENT AND OPERATING ENTITIES RESPONSIBLE FOR FEDERAL RECLAMATION PROJECTS.

Central Arizona Water Conservation District, Phoenix.

For primary bibliographic entry see Field 6E. W91-02265

INSTITUTIONAL ECONOMICS AND INDIAN WATER PROJECTS-DOES THE FRAMEWORK MAKE A DIFFERENCE.

Cornell Univ., Ithaca, NY. D. J. Allee.

ID. J. Auec.

IN: Indian Water Rights and Water Resources
Management. Proceedings of a Symposium. American Water Resources Association, Bethesda,
Maryland. 1989. p 53-62, 18 ref.

Descriptors: \*Economic aspects, \*Indian reserva-tions, \*Indian water rights, \*Institutional con-straints, \*Project planning, \*Water resources man-agement, \*Water rights, Social aspects.

Better options are, in part, a function of the analytical framework that is brought to resource management. Neoclassical economics has been used to structure cost-benefit analysis of water projects. Rules based on related financial concepts limit the degree of subsidy. Very different results in the formulation and evaluation of projects appear likely if concepts from institutional economics are applied as a supplement to those based solely on more conventional economics. In particular, the differences in the Angle and Indian cultures can be differences in the Anglo and Indian cultures can be more explicitly taken into account. The results more explicitly taken into account. The results may make water projects more effective instruments for capacity building. Concepts of instrumental efficiency compliment the conventional economic and financial concepts and provide conceptual limits for the adjustment of the rules based on those conventional concepts. The results may have application to subsets of the non-Indian society as well. (See also W91-02262) (Author's abstract) stract) W91-02268

IMPROVING THE PROSPECTS OF NEGOTI-ATED SETTLEMENT OF AMERICAN INDIAN WATER RIGHTS DISPUTES.

Colorado Univ. at Denver. Graduate School of

For primary bibliographic entry see Field 6E. W91-02273

FROM ZERO TO 20 MGD IN TEN MONTHS. Indianapolis Water Co., IN.

For primary bibliographic entry see Field 5F.

APPROACH TO THE INVENTORY OF FOR-ESTED WETLANDS FOR TIMBER-HARVEST-ING IMPACT ASSESSMENT.

North Carolina State Univ. at Raleigh. School of Forest Resources

For primary bibliographic entry see Field 4C. W91\_02485

APPLICATION OF THE ANALYTIC ELE-MENT METHOD FOR NATIONAL GROUND-WATER MANAGEMENT IN THE NETHER-LANDS.

Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands). W. J. DeLange.

W. J. DeLange.
IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 285-293, 5 fig. 1 tab, 3 ref.

Descriptors: \*Alternative planning, \*Groundwater management, \*Hydrologic models, \*Model studies, \*Planning, \*Water quality management, \*Water resources management, Analytical methods, Crop-land, Marsh management, Policy making, Water policy, Water supply development.

In the Netherlands a national integral water man agement program controls both groundwater and surface water management with all their aspects. A complex system of instruments has therefore been developed including an instrument for groundwater management. This recently-developed instrument was used in a background analysis of man-agement alternatives. Three causes of drying up of agement atternatives. Inree causes of drying up of crops and vegetation in the Drenthe Plateau were analyzed: (1) extraction of wells, (2) polder level manipulations in the valleys, and (3) changes in the drainage resistance in the valleys. It appeared that all three cause important effects stretched out over large domains, but at different places and with different magnitudes. One of the scenarios for re-generation of wet nature domains suggested reallo-cation of wells. Because the groundwater model is based on the analytical element method, it meets the requirements for flexibility in the use of scales and for nationwide comparability of the results. Effects on groundwater of the alternatives concerning large domains can be presented in a clear and accurate way to policymakers. (See also W91-02672) (Fish-PTT) W91-02697

AQUIFERS AS COMPONENTS OF WATER RESOURCES SYSTEMS.

TAHAL-Water Planning for Israel Ltd., Tel-Aviv. For primary bibliographic entry see Field 4B.

REGIONALIZATION SCHEMES FOR THE MANAGEMENT OF LARGE WATER RESOURCES SYSTEMS.

Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos. For primary bibliographic entry see Field 4B. W91-02711

ROLE OF GROUNDWATER IN ISRAEL'S IN-TEGRATED WATER SYSTEM.

TAHAL-Water Planning for Israel Ltd., Tel-Aviv. For primary bibliographic entry see Field 4B. W91-02714

# 6B. Evaluation Process

DESIGN AND MANAGEMENT OF RURAL WATER SUPPLY PROJECTS: LESSONS LEARNED FROM COMPARATIVE STUDY OF USAID PROJECTS IN BURKINA FASO AND

Water and Sanitation for Health Project, Arlington, VA.

For primary bibliographic entry see Field 5F. W91-02362

#### Field 6-WATER RESOURCES PLANNING

### **Group 6B—Evaluation Process**

STREAMSIDE MANAGEMENT UNITS IN THE PACIFIC NORTHWEST.
Forest Service, Portland, OR. Pacific Northwest

Forest Service, Portland, OR. Pacific Northwest Region. G. W. Swank.

Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 419-424, June 1990. 1 tab.

Descriptors: \*Forest ecosystems, \*Forestry, \*Forests, \*Oregon, \*Riparian areas, \*Streamside Management Unit, \*Washington, \*Water quality, \*Water quality management, Fisheries, Management planning, Resources management, Riparian waters, Streams.

The riparian areas in the Pacific Northwest are an extremely important social, economic, and environmental part of the Regional and National Forest land base. These multi-use sites, however, support fish-bearing streams, lakes and resevoirs, wetlands and floodplains, wildlife habitats, recreational sites, cow and sheep forage, and timber production which often compete with each other. The Streamside Management Unit (SMU) Policy in the National Forests of Oregon and Washington addresses one of these concerns—the water quality and fisheries including the area in and immediately adjacent to streams. The SMU concept is a stream classification system based on water use with specific water quality objectives established for each of the four classes of streams. The underlying premise is that the land immediately adjacent to streams is the key to protecting water quality. Through the use of SMUs, this land can be effectively monitored and managed not only to protect the riparian habitats but also, in most cases, to retain a reasonable return on other resource values. (D'Agostino-PTT)

GUIDELINES FOR DEVELOPING A PROJECT.

Freese and Nichols, Inc., Fort Worth, TX. R. R. Longoria, D. C. Lewis, and D.

Hargesheimer. Water Environment & Technology WAETEJ, Vol. 2, No. 10, p 71-76, October 1990. 8 tab.

Descriptors: \*Management planning, \*Project planning, \*Reclaimed water, \*Water reuse, \*Water supply development, Data requirements, Potable water, Public participation, Texas, Water quality standards, Water resources data, Water resources management, Water treatment.

management, Water treatment.

A four-phase planning effort was used in the development of a water reclamation/reuse project initiated in 1988 to indirectly augment potable water supplies for Abilene, TX, by increasing the flows into the surface water supply reservoir. The four work phases focused on project definition and formation, creation of baseline data, treatment process evaluation and selection, and implementation. Under this management approach, each phase is nearly independent, with distinct orientation meetings and schedules. Phase 1 involves formation of the project team, including a public advisory committee (PAC), and requires the project of develop, in detail, the specific goals and objectives of the project. In Phase 2, the project team compiles fact sheets of relevant baseline information on a specific subject. Because available data may be incomplete or of questionable validity, supplemental data should be acquired. In Phase 3, fundamental technical information is developed. Water quality standards are identified, computer modeling is conducted to determine the impact of the standards on the receiving water, and treatment alternatives are developed and evaluated. By the onset of Phase 4, the major technical memoranda are completed and the project team should be ready to draft the summary report. At this stage, estimated costs should be considered in planning budget estimates. The water quality monitoring program should be continued through Phase 4 to provide data needed to evaluate the impact of the reuse improvements. Financing options for a reclamation project are similar to those for conventional wastewater treatment systems. In addition, the development of a public information and acceptance program (for reused water) should begin with the study and continue throughout the implementation phase. (VerNooy-PTT)

W91-02567

EVALUATION OF THE NUTTING LAKE DREDGING PROGRAM. Baystate Environmental Consultants, Inc., East Longmeadow, MA.

Longmeadow, MA. For primary bibliographic entry see Field 5G. W91-02617

FEASIBILITY STUDY ON THE GROUNDWATER DEVELOPMENT FOR THE WATER SUPPLY OF AN OIL SHALE PROCESSING PLANT IN CENTRAL JORDAN.

Bundesanstalt fuer Geowissenschaften und Roh-

Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
For primary bibliographic entry see Field 4B.
W91-02720

APPLIED LAND CLASSIFICATION FOR SURFACE WATER QUALITY MANAGEMENT: I. WATERSHED CLASSIFICATION. National Chunghsing Univ., Taichung (Taiwan). Graduate Inst. of Urban Planning. For primary bibliographic entry see Field 5G. W91-02947

APPLIED LAND CLASSIFICATION FOR SURFACE WATER QUALITY MANAGEMENT: II. LAND PROCESS CLASSIFICATION. National Chunghsing Univ., Taichung (Taiwan). Graduate Inst. of Urban Planning. For primary bibliographic entry see Field 5G. W91-02948

# 6C. Cost Allocation, Cost Sharing, Pricing/Repayment

INDIAN WATER RIGHTS SETTLEMENTS: THE ROLE OF LOCAL REPAYMENT AND OPERATING ENTITIES RESPONSIBLE FOR FEDERAL RECLAMATION PROJECTS. Central Arizona Water Conservation District,

Phoenix. For primary bibliographic entry see Field 6E. W91-02265

TRANSACTION COSTS AND RESOLUTION OF RESERVED RIGHTS CLAIMS.
Utah State Univ., Logan. Dept. of Economics. For primary bibliographic entry see Field 6E. W91-02267

INSTITUTIONAL ECONOMICS AND INDIAN WATER PROJECTS-DOES THE FRAMEWORK MAKE A DIFFERENCE.

Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 6A.
W91-02268

FORESTED-WETLAND TRENDS IN THE UNITED STATES: AN ECONOMIC PERSPECTIVE.
Southern Forest Experiment Station. New Orle-

Ans, LA.
For primary bibliographic entry see Field 2H.
W91-02486

TECHNOLOGIES AND COSTS FOR THE TREATMENT OF MICROBIAL CONTAMINANTS IN POTABLE WATER SUPPLIES.
Pirnie (Malcolm), Inc., Paramus, NJ.
For primary bibliographic entry see Field 5F.
W91-02614

ECONOMIC BENEFIT CONSIDERATIONS IN SELECTING WATER QUALITY PROJECTS. INSIGHTS FROM THE RURAL CLEAN WATER PROGRAM.

Economic Research Service, Washington, DC. Resources and Technology Div.
For primary bibliographic entry see Field 5G.
W91-02622

MODELS FOR A RATIONAL UTILIZATION OF HIGH QUALITY GROUNDWATER RESOURCES.

Dortmund Univ. (Germany, F.R.). Inst. for Environmental Protection. For primary bibliographic entry see Field 3E. W91-02715

COST SUPPLEMENT TO TECHNOLOGIES AND COSTS FOR THE REMOVAL OF MERCURY FROM POTABLE WATER SUPPLIES. Environmental Protection Agency, Washington, DC. Criteria and Standards Div. For primary bibliographic entry see Field 5F. W91-02725

COST SUPPLEMENT TO TECHNOLOGIES AND COSTS FOR THE REMOVAL OF NI-TRATES AND NITRITES FROM POTABLE WATER SUPPLIES.

Environmental Protection Agency, Washington, DC. Criteria and Standards Div. For primary bibliographic entry see Field 5F. W91-02726

COST SUPPLEMENT TO TECHNOLOGIES AND COSTS FOR THE REMOVAL OF CHROMIUM FROM POTABLE WATER SUPPLIES. Environmental Protection Agency, Washington, DC. Criteria and Standards Div. For primary bibliographic entry see Field 5F. W91-02727

COST SUPPLEMENT TO TECHNOLOGIES AND COSTS FOR THE REMOVAL OF SELE-NIUM FROM POTABLE WATER SUPPLIES. Environmental Protection Agency, Washington, DC. Criteria and Standards Div. For primary bibliographic entry see Field 5F. W91-02728

COST SUPPLEMENT TO REMOVAL OF CAD-MIUM FROM POTABLE WATER SUPPLIES, Environmental Protection Agency, Washington, DC. Criteria and Standards Div. For primary bibliographic entry see Field 5F. W91-02729

COST SUPPLEMENT TO TECHNOLOGIES AND COSTS FOR THE REMOVAL OF ASBESTOS FROM POTABLE WATER SUPPLIES. Environmental Protection Agency, Washington, DC. Criteria and Standards Div. For primary bibliographic entry see Field 5F. W91-02730

PRETEST ANALYSES OF WATER DEMAND IN THIRTY COMMUNITIES. Texas A and M Univ., College Station. Dept. of Agricultural Economics. For primary bibliographic entry see Field 6D. W91-02857

REGIONAL SLUDGE MANAGEMENT PLAN-NING IN VERMONT. Dufresne-Henry, Inc., North Springfield, VT. For primary bibliographic entry see Field 5E. W91-02954

#### 6D. Water Demand

DEVELOPMENT OF TURKEY'S ELECTRIC ENERGY.
State Hydraulic Works, Ankara (Turkey).
For primary bibliographic entry see Field 8C.
W91-02110

FRESHWATER WITHDRAWALS IN TEXAS, 1985. Geological Survey, Austin, TX. Water Resources Div.

# Water Law and Institutions—Group 6E

W91-02228

ESTIMATED DEMAND FOR AGRICULTURAL WATER FOR USE IN NEW JERSEY, 1990.
Geological Survey, Trenton, NJ. Water Resources

DIV.

E. O. Titus, R. M. Clawges, and C. L. Qualls.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS

Open-File Report 90-156, 1990. 53p, 2 fig. 12 tab, 6

Descriptors: \*Drought, \*Hydrologic budget, \*New Jersey, \*Soil moisture deficiency, \*Water use, Agricultural water, Irrigation water.

As part of an effort to determine if an adequate supply of agricultural water for irrigation use will be available to farmers, the U.S. Geological Survey prepared preliminary estimates of demand for agricultural water for irrigation use for the year 1990 on the basis of six possible scenarios. These scenarios incorporate normal and drought climatic conditions and three alternative estimates of the conditions and three alternative estimates of the total acreage of farmland that may be irrigated in 1990. Preliminary estimates of water demand based on soil-moisture deficits were made using methods for calculating climatic water budgets. These estimates ranged from 3.0 billion gal/growing season (May through September), under normal climatic conditions and a 2% annual decline in irrigated acreages given 1984 to 2.89 billion gal/growing conditions and a 2% annual decline in irrigated acreage since 1984, to 28.9 billion gal/growing season, under drought conditions and a 2% annual increase in irrigated acreage since 1984. Preliminary estimates of water demand made for the 1986. growing season reasonably approximate reported water use for that period. (USGS)
W91-02246

MISSOURI RIVER MANAGEMENT PROJECT: LEARNING TO COOPERATE. bibliographic entry see Field 6A.

WATER TRANSFERS AND PAPER RIGHTS IN THE TRUCKEE AND CARSON RIVER RASINS

Environmental Defense Fund, Oakland, CA. For primary bibliographic entry see Field 6E. W91-02266

NON-INDIAN WATER USERS' GOALS: MORE IS BETTER, ALL IS BEST.
Jennings, Strouss and Salmon, Phoenix, AZ.
For primary bibliographic entry see Field 6E.
W91-02270

SALT RIVER PIMA-MARICOPA INDIAN COMMUNITY WATER RIGHTS SETTLEMENT ACT OF 1988.

Department of the Interior, Phoenix, AZ. Office of the Field Solicitor. For primary bibliographic entry see Field 6E. W91-02271

ANALYSIS OF THE SALT RIVER PIMA-MAR-ICOPA INDIAN COMMUNITY WATER RIGHTS SETTLEMENT. For primary bibliographic entry see Field 6E. W91-02272

GROUNDWATER OWNERSHIP AND CONTROL IN INDIAN COUNTRY. Du Bey Law Firm, Seattle, WA. For primary bibliographic entry see Field 6E. W91-02277

SALMON AND THE SNAKE: MEETING FISH FLOW OBJECTIVES IN A SEMI-ARID RIVER

Watershed Resources, Inc., Santa Fe, NM.

J. I Olisano.
IN: Indian Water Rights and Water Resources
Management. Proceedings of a Symposium. American Water Resources Association, Bethesda,

Maryland. 1989. p 175-186, 1 fig, 23 ref.

Descriptors: \*Competing use, \*Fish migration, \*Fisheries, \*Indian water rights, \*River flow, \*Salmon River, \*Snake River Basin, \*Water resources management, Hydroelectric powerplants, Idaho, Irrigation, Water resources development,

The primary uses of water in the upper Snake River basin in Idaho are for irrigation and hydropower production. Present water resource management strategies in the basin have emphasized these users to the detriment of other resources, especially anadromous fish. In the era before water resources development, anadromous fish were carried to the ocean during the juvenile life phase by the relatively high flows of the spring and summer natural runoff, completing the journey in as little as 4 days. Migration can now take more than 1.5 months with resultant significant mortalities. An analysis of the hydrology and water use charactermonths with resultant significant mortalities. An analysis of the hydrology and water use characteristics within the basin indicates that more than 3 million acre-feet (MAF) of additional water could be made available for anadromous fish migrations, especially during the critical juvenile out-migration period, without curtailing existing uses. These opportunities for improved flows for fish include new storage and changes to existing operations for reservoir releases, irrigation diversions, and water rights transfers in Idaho. (See also W91-02262) (Author's abstract) (Author's abstract) W91-02279

WATER LOSSES IN THE NILE BASIN, International Inst. for Hydraulic and Environmen-tal Engineering, Delft (Netherlands). For primary bibliographic entry see Field 2A. For primar W91-02298

WATER CONSERVATION IN DROUGHT-STRICKEN SANTA BARBARA COUNTY-RE-SPONSE IS SLOW. Lawrance, Fish and McFarland, Inc., Santa Bar-

For primary bibliographic entry see Field 3D. W91-02423

MAYA UTILIZATION OF KARST GROUND-WATER RESOURCES.

Pennsylvania State Univ., University Park. G. Veni.

Environmental Geology and Water Sciences EGWSEI, Vol. 16, No. 1, p 63-66, 1990. 11 ref.

Descriptors: \*Groundwater management, \*History, \*Karst hydrology, \*Life history studies, \*Water resources development, \*Water resources management, Belize, Caves, Groundwater pollution, Guatemala, Honduras, Mexico, Semiarid lands, Springs, Surface water availability.

Much of the Maya civilization in pre-Columbian Meso-America was established on karst terrain that included parts of what are now Belize, Guatemala, northern Honduras and southern Mexico. By defi-nition, little surface water exists in karst, so for the Maya to flourish on that terrain they had to effec-tively and efficiently utilize all their water resources. Access to groundwater was by means of springs and caves. Maya life, urban and rural, lay and elite, religious and secular, was often a func-tion of groundwater exploitation and surface water tion of groundwater exploitation and surface water development. The Maya's use of groundwater was predominantly to supplement enhanced surface water supplies and was used more often in semiarid zones than in humid zones. The pattern of Maya settlements, especially in the semiarid zones, cocurred in areas with greater access to the groundwater. Maya groundwater retrieval methods were primitive, inefficient, labor intensive, and uninnovative, as compared to their other technologic achievements. Groundwater contamination, from human effluent, could have resulted in widespread disease and contributed to the Maya's downfall. (Author's abstract)

PRETEST ANALYSES OF WATER DEMAND IN THIRTY COMMUNITIES.

Texas A and M Univ., College Station. Dept. of Agricultural Economics. R. C. Griffen, and C. Chang. Water Resources Research WRERAQ, Vol. 26, No. 10, p 2251-2255, October 1990. 2 fig, 6 tab, 24

Descriptors: \*Pricing, \*Texas, \*Water costs, \*Water demand, \*Water use, Capital costs, Cli-mates, Model studies, Seasonal variation, Sewage rate, Water rates.

Using three years of monthly data for 30 carefully selected Texas communities, several characteristics of community water demand, including pricing structures, are investigated using a demand model containing six variables: per capita residential and commercial water consumption, average price of water paid by an average 2.84 person household, marginal price of water paid by an average 2.84 person household, marginal price of water paid by an average 2.84 person household, annual personal income per capita, percent of the population with Spanish origin, and a climate variable. Average price versus marginal price specifications demonstrate the superiority of the average price approach. More original contributions identify the need to include sewer rates in water demand models, the importance of studying seasonal demand rather Using three years of monthly data for 30 carefully include sewer rates in water demand models, the importance of studying seasonal demand rather than annual demand, seasonal variations in the price elasticity of demand, and an index for relating monthly community water demand to monthly climatic conditions. Results clearly indicate summer price elasticities which are about 50% higher than winter elasticities. Coupled with the fact that capital expenditures to create peak load capacities represent a large proportion of utility costs, time of year rates are favored. (Brunone-W91-02855

### 6E. Water Law and Institutions

STREAMFLOW DATA AND SURFACE WATER RESOURCE ASSESSMENT • A QUANTITATIVE DEMONSTRATION OF NEED FOR ADEQUATE INVESTMENT IN DATA COLLECTION IN DEVELOPING COUNTRIES.

Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering. For primary bibliographic entry see Field 7A. W91-02141

INDIAN WATER RIGHTS AND WATER RE-SOURCES MANAGEMENT.

Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1989. 1889. Edited by William B. Lord and Mary G. Wallace.

Descriptors: \*Indian reservations, \*Indian water rights, \*Legal aspects, \*Symposium, \*Water law, \*Water rights, Administration, Competing use, Social aspects, Water resources management, Water use.

Indian water rights have come to be one of the Nation's most important water resource issues. Indian water rights claims are presently being adjudicated in almost every Western state. These claims are usually very senior and also unquantified. How these claims will be satisfied will affect fied. How these claims will be satisfied will affect water use and management in most of the West. The parties affected by these conflicts have different objectives. Tribes look to securing and using water rights as a major hope for achieving self-sufficiency, furthering tribal sovereignty, and maintaining cultural pluralism. Non-Indian water users seek to safeguard long established water uses and remove uncertainties about future water entitlements. States with to essert state repropability. and remove uncertainties about future water entitlements. States wish to assert state responsibility
and authority for water allocation and to preserve
the integrity of state water laws and administrative
systems. The federal government has many interests, ranging from its trust responsibilities to Indian
tribes through such specific responsibilities as environmental protection, and fulfilling commitments
to users of federal project water, to its general
responsibility to minimize the financial burdens
placed upon the Nation's taxpayers. Resolving
Indian water rights conflicts within this context of

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multiple aspirations and viewpoints has been ex-tremely difficult. Litigation has produced very few settlements, and negotiation and legislation have been only slightly more successful. All parties share a common interest in finding better and more share a common interest in finding better and more lasting ways of settling these disputes. The purpose of this symposium is to assess the collective experience in resolving Indian water rights conflicts, to examine all possibilities for solutions, and to forge new conceptual bases for moving from the winlose situations which preclude easy settlement to win-win situations from which all can benefit. (See W91-02263 thru W91-02279) (Lantz-PTT)

INDIAN WATER CLAIMS NEGOTIATIONS:

CONFLICTING FEDERAL ROLES.
Department of the Interior, Washington, DC.
Office of Program Analysis.

B. Simon.

IN: Indian Water Rights and Water Resources
Management. Proceedings of a Symposium. American Water Resources Association, Bethesda,
Maryland. 1989. p 1-10, 1 tab, 6 ref.

Descriptors: \*Conflicting use, \*Federal jurisdiction, \*Indian reservations, \*Indian water rights, \*Legal aspects, \*Water rights, Political aspects, Water law, Water resources management.

In recent years the Federal government has at-tempted to negotiate rather than litigate Indian water claims, and has found that negotiations are water claims, and has found that negotiations are not a panacea. To obtain effective settlements, the Government needs to take full advantage of all available mechanisms (including litigation) for settling Indian water claims. But there are cases that are well suited to negotiations. Much of the success of the negotiation process depends on the effectiveness of the Federal government, a major player in all Indian water rights negotiations. Past negotiations have shown that: (1) effective negotiations to the property of t negotiations in a ve shown intal: (1) enecutive negotiations require solid organization with high level support from political leadership. If high level support is lacking, Federal negotiators are at a decided disadvantage in any negotiation; (2) even decided disadvantage in any negotiation; (2) even if all ideal conditions are present, the Federal government can be expected to appear indecisive at times because it is subject to internal conflict; and (3) important precedents concerning federal financing of settlements and protection of existing water users have been established by the cases settled during the last 6 years which can be used as a base of guidance for future negotiations. (See also W91-02262) (Lantz-PTT) W91-02263

INDIAN WATER RIGHTS SETTLEMENTS: THE ROLE OF LOCAL REPAYMENT AND OPERATING ENTITIES RESPONSIBLE FOR FEDERAL RECLAMATION PROJECTS.
Central Arizona Water Conservation District,

Process.

D. K. Miller.

IN: Indian Water Rights and Water Resources
Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1989. p 21-31, 2 fig.

Descriptors: "Cost allocation, "Federal jurisdiction, "Indian reservations, "Indian water rights, "Legal aspects, "Water resources management, "Water rights, Competing use, Costs, Economic aspects, Land reclamation, Salt River Pima-Maricons Indian Community." copa Indian Community.

The role of the repayment contractor and operator The role of the repayment contractor and operator of a major federal reclamation project, in the negotiation and settlement of a significant Indian Water Rights claim was examined. The example used is the settlement of the water rights claims of the Salt River Pima-Maricopa Indian Community, recently authorized by Congress. In this case, the Central authorized by Congress. In this case, the Central Arizona Water Conservation District (CAWCD) participation in the settlement process established an important principle of consultation. Repayment and operating agencies responsible for federal reclamation projects must determine their appropriate role in Indian water rights negotiations and the extent to which their resources should be devoted to the settlement of Indian water rights claims. If participation is judged to be appropriate, the agencies must then evaluate the impact of the settlement on: (1) project water supplies; (2) project water users; (3) system capacity; (4) project power supplies; (5) operation, maintenance and repair costs; and (6) the repayment of project costs. Vigorous and sustained participation in settlement necitations will be necessary to protect the agency. orous and sustained participation in settlement negotiations will be necessary to protect the agency's interests. Frequent consultation among staff of the agency, its governing body, and its water users concerning the progress of negotiations will be required in order to avoid mistakes and to gain political support for eventual compromises. (See also W91-02262) (Lantz-PTT) W01-02262) also W91-02 W91-02265

WATER TRANSFERS AND PAPER RIGHTS IN THE TRUCKEE AND CARSON RIVER BASINS

Environmental Defense Fund, Oakland, CA.

Environmental Decense, a title, Sand Water Resources IN: Indian Water Rights and Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1989. p 33-42, 2 fig. 1 tab, 31 ref.

Descriptors: \*Carson River Basin, \*Conflicting use, \*Indian water rights, \*Legal aspects, \*Truckee River Basin, \*Water resources management, \*Water rights, \*Water transfer, \*Water use, Indian reservations, Pyramid Lake, Regulations, Wet-

Federal regulatory actions in Nevada's Truckee and Carson River Basins have resulted in a painful environmental choice between water for Pyramid Lake and water for the Stillwater and other La-hontan Valley wetlands. Water rights acquisitions have become a leading policy alternative in efforts to avoid this environmental tradeoff, the roots of which can be found in turn-of-the-century reclama-tion efforts which ignored the needs of both resources. Recent and contemplated acquisitions in-volving 'inactive' water rights threaten to perpetuate the conflict, however, while attempts to limit such purchases are frustrated by unresolved legal sucn purchases are trustrated by unresolved legal and equity issues over the status of inactive entitlements. An overview of the controversy, including the disparate interests of Newlands Project farmers and the Pyramid Lake Paiute and Fallon Paiute-Shoshone Tribes, illuminates the importance of developing an acquisition oriented activity stand-ard that is cognizant of those claims. If water rights acquisitions are to diffuse the environmental conflicts, however, an activity standard must come into play. (See also W91-02262) (Author's abstract) W91-02266

TRANSACTION COSTS AND RESOLUTION OF RESERVED RIGHTS CLAIMS.

Utah State Univ., Logan. Dept. of Economics.
D. L. Snyder, and J. C. Andersen.
IN: Indian Water Rights and Water Resources
Management. Proceedings of a Symposium. American Water Resources Association, Bethesda,
Maryland. 1989. p 43-52, 8 ref.

Descriptors: \*Competing use, \*Cost-benefit analysis, \*Costs, \*Indian water rights, \*Legal aspects, \*Water rights, Economic aspects, Feasibility studies. Water resources management.

Transaction costs are an important consideration in transferring resources among competing uses. This concept is particularly relevant in the case of reserved water rights. Beginning with Winters vs. US in 1906, the US Supreme Court has consistent. If yruled that water rights exist on federal reservations consistent with the purpose for which each reservation was established. While ruling that such rights existed, the Court did not provide any usable means whereby those rights could be quantified. However, a basis for quantification has emerged in subsequent cases; that of Practicably Irrigable Acreage or PIA. An essential element of PIA is economic feasibility as measured by a cost-benefit Transaction costs are an important consideration in economic feasibility as measured by a cost-benefit ratio greater than one. Considerable controversy and transaction costs surround the application of PIA and economic feasibility as applied to the quantification of reserved water rights. The use of economic feasibility, however, as a decision rule

encourages abuse of the economic concepts, and methods of analysis become subject to distortion and bias. The real implications of the application of economic feasibility have either not been addressed by those involved or have been ignored. As long as the implications are ignored, little useful information can be derived from any analysis of economic feasibility. (See also W91-02262) (Lantz-PTT) W91-02267

STATE GOALS IN INDIAN WATER RIGHTS

P. W. Sly. IN: Indian Water Rights and Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1989. p 63-71.

Descriptors: \*Governmental interrelations, \*Indian reservations, \*Indian water rights, \*Legal aspects, \*State jurisdiction, \*Water resources management, \*Water rights, Federal jurisdiction, Institutional constraints. Regulations.

State goals in Indian water rights litigation and legislation fall within four general areas: (1) regulatory and adjudicatory simplicity, (2) protection of state proprietary and fiscal interests, (3) protection of water rates based on state law against rights based on federal law, and (4) interstate goals. All states seek regulatory simplicity and predictability. Some are pursuing relative certainty by direct negotiation with Indian tribes. State proprietary and interstate interests are site specific, depending on the hydrology of each reservation and affected non-indian areas. State 'representative federalism' non-Indian areas. State 'representative federalism' against Indian rights depends on hydrology, population and landholding patterns within and near reservations, and the water institutions within the reservations, and the water institutions within the state. The strong state interest in certainty of rights to a limited water resource has led states to explore negotiation with Indian tribes. Ultimate self-determination for states and tribes may be best served by negotiations which can tailor an agreement to meet existing needs without the costs, friction and delay of litigation. (See also W91-02262) (Lantz-PTT) W91-02269

NON-INDIAN WATER USERS' GOALS: MORE IS BETTER, ALL IS BEST.

Jennings, Strouss and Salmon, Phoenix, AZ.

J. B. Weldon.

IN: Indian Water Rights and Water Resources
Management. Proceedings of a Symposium. American Water Resources Association, Bethesda,
Maryland. 1989. p 73-85.

Descriptors: \*Indian reservations, \*Indian water rights, \*Legal aspects, \*Water resources management, \*Water rights, \*Water use, Competing use, Public policy, Water demand.

The doctrine of prior appropriation has governed water use by non-Indians in most Western states for over a century. Under the doctrine, a water user is entitled to that amount of water which the water user has diverted and put to a beneficial use. water user has diverted and put to a beneficial use. The following goals have been proposed for water appropriation: (1) establish the validity of one's own water rights claims against those of all competing water users; (2) obtain a permanent quantification of federal reserved and Indian water rights in order to (a) provide certainty with respect to the division of the water supply, (b) to permanently settle upon specific water right entitlement for each Indian tribe in order to avoid continued expansion of that entitlement due to technological improvements or changing legal doctrines. (c) pansion of that entirement due to terminologies, improvements or changing legal doctrines, (c) remove potential damages claims by or on behalf of the tribe for interference with their water rights, and (d) force consideration of federal/state water and (a) force consideration of rederal/state water policy changes to allow parties to live with the outcome; and (3) create opportunities to build co-operative relationships between Indian and non-Indian communities, including negotiated resolu-tion of water rights conflicts where all parties can be considered winners. (See also W91-02262) (Lantz-PTT)

## Water Law and Institutions—Group 6E

SALT RIVER PIMA-MARICOPA INDIAN COMMUNITY WATER RIGHTS SETTLEMENT

COMMUNITY WATER RIGHTS SETTLEMENT ACT OF 1988, Department of the Interior, Phoenix, AZ. Office of the Field Solicitor. W. H. Swan.

W. H. Swan. IN: Indian Water Rights and Water Resources Management. Proceedings of a Symposium. Amer-ican Water Resources Association, Bethesda, Maryland. 1989. p 87-93.

Descriptors: \*Arizona, \*Indian water rights, \*Legal aspects, \*Legislation, \*Salt River, \*Water resources management, \*Water rights, \*Water exc. Competing use, Groundwater, Indian reservations, Phoenix, Riparian rights, Salt River Pima-Maricopa Indian Community, Salt River Project.

Following years of negotiations, Congress approved the Salt River Indian Water Rights Settlement Act in October 1988. This settlement is the first Indian water rights settlement which involves the major urban area of the State of Arizona, the Phoenix metropolitan area, and also the major water developer-user in the state, the Salt River Project. Basically, the settlement provides that the Community will have the use of 122,400 acre ft/yr Community will have the use of 122,400 acre ft/yr developed from the following components: (1) Kent Decree water, with storage provided via Central Arizona Project (CAP) storage space; (2) Contribution of stored water from Salt River Project (SRP)-9,074 acre ft; (3) Bartlett Dam agreement water-20,000 acre ft; (4) CAP entitlement-13,300 acre ft; (5) Contribution from the Roosevelt Water Conservation District-8,000 acre ft; (6) Contribution from the Roosevelt Irrigation District-10,000 acre ft; (7) Contribution from valley cities in the amount of 20,000 acre ft from city lands within the SRP area; and (8) Developed groundwater on the reservation-23,250 acre ft. The Salt River settlement provides an important precedent with regard to other potential Indian water rights settlements in Arizona and in other water rights settlements in Arizona and in other states. Many of the remaining Indian water rights disputes in Arizona present situations of similar complexity, and therefore it is important that the complexity, and therefore it is important that the non-Indian participants now recognize that settlements such as these can be accomplished with sufficient dedication of time, attention and creativity. (See also W91-02262) (Lantz-PTT) W91-02271

ANALYSIS OF THE SALT RIVER PIMA-MARICOPA INDIAN COMMUNITY WATER
RIGHTS SETTLEMENT.
N. H. Starler, and K. G. Maxey.
IN: Indian Water Rights and Water Resources
Management. Proceedings of a Symposium. American Water Resources Association, Bethesda,
Maryland. 1989. p 95-113, 2 Tab.

Descriptors: \*Indian reservations, \*Indian water rights, \*Legislation, \*Salt River, \*Water resources management, \*Water rights, \*Water use, Arizona, Competing use, Evaluation, Federal jurisdiction, Phoenix, Riparian rights, Salt River Pima-Maricopa Indian Communit, Salt River Project.

In late 1988, Public Law 100-512 was enacted authorizing the implementation of a water rights settlement agreement among the Salt River Pima-Maricopa Indian Community (SRPMIC), local non-Indian public agencies in Arizona, and the Federal Government. The most difficult issues that were addressed during the negotiation of the settlement agreement and the implementing legislation were the appropriate level and division of Federal and local cost sharing for the settlement, and how to measure those contributions. During the latter stages of the negotiations, these issues became critical, and shaped much of the character of the settlement. This paper presents three different analyses used to evaluate the relative contributions the initial position adopted by the non-federal participants in their analysis of the relative contributions to the settlement. A second analysis represents the Federal re-analysis of those proposed contributions, the identification and measurement of other financial effects, and a summation of the final settlement cost sharing. Last an additional In late 1988, Public Law 100-512 was enacted of other financial effects, and a summation of the final settlement cost sharing. Last, an additional Federal analysis of the settlement is presented

based on the relative legal exposure of the non-Indian settlement participants compared to that of the Federal government. It should be recognized that the Federal government is far from a homogethe Federal government. It should be recognized that the Federal government is far from a homogeneous entity in this situation. Ultimately, the negotiated cost sharing between Federal and non-Federal parties came down to both a subjective and objective calculation of risk, liability and equity parameters involved. (See also W91-02262) (Lantz-TTT). parameters PTT) W91-02272

IMPROVING THE PROSPECTS OF NEGOTI-ATED SETTLEMENT OF AMERICAN INDIAN WATER RIGHTS DISPUTES.

Colorado Univ. at Denver. Graduate School of Public Affairs

Public Attairs.
L. Burton.
IN: Indian Water Rights and Water Resources
Management. Proceedings of a Symposium. American Water Resources Association, Bethesda,
Maryland. 1989. p 115-125, 15 ref.

Descriptors: \*Indian reservations, \*Indian water rights, \*Legislation, \*Water demand, \*Water rights, Federal jurisdiction, Governmental interrelations, Management planning, Planning, Water resources management.

Current efforts to compel American Indian tribes to negotiate the settlement of their water rights claims are fundamentally flawed, because of both a serious and irreconcilable conflict of interest claims are fundamentally flawed, because of both a serious and irreconcilable conflict of interest within the Interior Department (which is purporting to sponsor these negotiations), and Congress' historic failure to fully honor such agreements once made. The negotiation process could be made more fair by establishment of an American Indian Water Rights Commission, in which the department would participate but which it would not control. The functions of such a commission would include intergovernmental water resource planning, data base generation, model agreement drafting, the adoption of guidelines and principles for the negotiation process, and the empaneling of mediators and sponsorship of negotiations. In appropriated river basins, tribal claims may be honored in part by the voluntary market-based reallocation of existing supplies and the augmentation of existing supplies and the augmentation of existing supplies and the augmentation scriving through state-of-the-art conservation techniques applied to existing irrigation facilities. Commission activities, reallocation, and conservation retrofitting can be financed by the interest from a trust fund created by a 10 year surcharge on the sale of water and power from a trust fund created by a 10 year surcharge on Reclamation-managed facilities. (See also W91-02262) (Author's abstract)

INDIAN WATER RIGHTS: NEGOTIATION; AGREEMENT; LEGISLATIVE SETTLEMENT. Utah Univ., Salt Lake City. Dept. of Political

Science.
D. McCool.
IN: Indian Water Rights and Water Resources
Management. Proceedings of a Symposium. American Water Resources Association, Bethesda,
Maryland. 1989. p 127-134, 18 ref.

Descriptors: \*Indian reservations, \*Indian water rights, \*Legislation, \*Water resources management, \*Water rights, Colorado Ute Indian Water Rights Settlement, Competing use, Regulations, Salt River Pima-Maricopa Indian Community, San Luis Rey Indian Water Rights Settlement, Water

Three Indian water rights settlements were passed by Congress in 1988: the Colorado Ute Indian Water Rights Settlement Act, the San Luis Rey Indian Water Rights Settlement Act, and the Salt River Pima-Maricopa Indian Community Water Rights Settlement Act. Although each settlement act is unique, there are certain similarities and trends that can be discerned in the legislation. Themes are addressed which are common to these efforts to resolve Indian claims to water through a process which typically includes three stages: prolonged negotiation; an agreement signed by the principle parties; and the affirmation of that agreement via a legislative settlement act. (See also W91-02262) (Author's abstract)

W91-02274

CONSTRAINTS IN THE SALT RIVER PIMA-MARICOPA WATER RIGHTS SETTLEMENT

Arizona Univ., Tucson. Dept. of Agricultural Eco-

In: Indian Water Rights and Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1989. p 135-143, 1 fig. 12 ref.

Descriptors: \*Indian reservations, \*Indian water rights, \*Water resources management, \*Water rights, Legal aspects, Legislation, Marketing, Salt River Pima-Maricopa Water Rights Settlement,

The Salt River Indian Community's water rights were quantified through the Salt River Pima-Maricopa Water Rights Settlement Act. Two aspects of the Act which constrain the community's water use flexibility are discussed in this paper. The first deals with the per acre water allocation which is deals with the per acre water allocation which is considerably less than the amount allotted to the neighboring farmers in the Phoenix Active Management Area. This raises the question as to whether the Reservation will be able to fulfil the purposes for its creation. Second, the Act expressly limits the community's opportunities for marketing its waters. Relaxation of these marketing-related legal constraints would make the Act more consistent with the evolving water marketing policies throughout the West which are responding to maturing water economies and acknowledgements of scarcity. Regional water marketing activity indituring water economies and acknowledgements of scarcity. Regional water marketing activity indicates that leasing could be a stable source of income to the community. The policy-makers involved with the Salt River Pima-Maricopa Water Rights Settlement Act should remove the constraints imposed by the acre-foot per acre allottenent and introduce a leasing option. Through extension of the same property rights given to non-Indian water users, the sovereign Community could maximize the net social sand economic benefits of their waters. (See also W91-02262) (Lantz-PTT) PTT W91-02275

FLORIDA SEMINOLE INDIAN DISPUTE SET-TLEMENT INCLUDING WATER RIGHTS COMPACT AND MANUAL.

Blain and Cone, Tampa, FL.

L. M. Blain.

I. M. Diain.

IN: Indian Water Rights and Water Resources
Management. Proceedings of a Symposium. American Water Resources Association, Bethesda,
Maryland. 1989. p 145-151.

Descriptors: \*Florida, \*Indian reservations, \*Indian water rights, \*Legislation, \*Seminole Indians, \*Water resources management, \*Water rights, Competing use, Governmental interrelations, Manuals, Permits, Regulations, State jurisdiction, Water demand, Water supply.

The Seminole Tribe of Florida filed suit in 1978 against the State of Florida and South Florida Water Management District, claiming that the state had granted flowage easements over Indian lands without sufficient congressional approval or compensation. Value of the claims for ejectment, damages, inverse condemnation, and breach of trust, was uncertain but had an estimated potential of ten million dollars. Florida has a highly developed regional water management system. The disof ten million dollars. Florida has a highly developed regional water management system. The districts operate drainage and water supply facilities, regulate consumptive use of water and surface water management through a permit system, and other environmental protection. The South Florida Water Management District operates and maintains two large canals which transverse tribal and adjacent lands, supplying irrigation water and providing drainage facilities. One of the many components suggested in attempting to negotiate settlevoung drainage racilities. One of the many components suggested in attempting to negotiate settlement of the Seminole's claims was the formation of a water rights compact among the tribe, the State, and the water management district to establish the tribe's water rights within the framework of Flor-

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ida's water management system. Approving State legislation was necessary but before it could be enacted the water rights compact and its accompanying criteria manual had to be completed and agreements between the tribe and adjacent landowners had to be entered into. (See also W91-0262) kethod's abstract into. 02262) (Author's abstract) W91-02276

GROUNDWATER OWNERSHIP AND CONTROL IN INDIAN COUNTRY.
Du Bey Law Firm, Seattle, WA.
G. D. Parker.
IN: Indian Water Rights and Water Resources
Management. Proceedings of a Symposium. American Water Resources Association, Bethesda,
Maryland. 1989. p 153-164, 63 ref.

Descriptors: \*Groundwater resources, \*Indian reservations, \*Indian water rights, \*Water rights, \*Water supply, Federal jurisdiction, Groundwater quality, Legal aspects, Public policy, Regulations.

Current Federal Indian policy recognizes and supports Indian tribal claims to groundwater resources. Tribal claims to reservation groundwater may be asserted under the reserved water right doctrine, and as tribal proprietary rights. Indian tribes can strengthen tribal claims to groundwater in the same way that tribes assert ownership of other natural resources within the exterior boundaries of relations the property of the programment of the same way that tribe assert ownership of other natural resources within the exterior boundaries of relations the programment of the progra the same way that tribes assert ownership of other natural resources within the exterior boundaries of Indian reservations-through tribal proclamations, laws and contracts. Tribal governmental action to protect the quantity and quality of groundwater is supported by current federal law and policy. A tribe's ownership interest would be further enhanced through enactment of tribal resolutions proclaiming the tribe's sovereign and proprietary ownership of groundwater, and a demonstration that such waters are necessary to fulfill the purposes of the reservation. A tribe's groundwater rights should not be limited by a narrow application of the Winters doctrine. A tribes ownership interest in groundwater goes beyond an amount determined to be necessary to meet the purposes for which the reservation was created. The ability of a tribe to survive and become economically independent, depends on the resources of the reservation. In many instances, the quality and quantity of the groundwater resource is a key to the health of the reservation population and the quality of the reservation environment. Tribal governments must take action to protect their interests before groundwater reservas are collised diminished or archants. reservation environment. Those governments must take action to protect their interests before ground-water reserves are polluted, diminished or exhaust-ed. (See also W91-02262) (Lantz-PTT) W91-02277

ADVANCES TOWARDS WATER RESOURCES DEVELOPMENT THROUGH HYDROLOGI-CAL TRAINING AND EDUCATION,

Vizgazdalkodasi Tudomanyos Kutato Intezet, Bu-dapest (Hungary).

G. Kienitz.

IN: The State-of-the-Art of Hydrology and Hydrogoology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 68-89, 2 fig, 3 tab, 4 ref.

Descriptors: \*Africa, \*Developing countries, \*Education, \*Hydrology, \*Training, \*Water resources development, Financing, Management planning,

In Africa, the unfavorable spatial and temporal distribution of rainfall necessitates human intervention in the hydrological regime to provide protection against flooding and for counteracting droughts. The basis of water resources development is a thorough knowledge of the hydrological regime and of the involved laws of nature. An adequate number of experts in water resources development combined with a proper knowledge of hydrology is a preliminary to general economic development in a country. The systematic measurement of hydrological elements should be regarded by any administration as an indispensable basic task carried out for the sake of future developments. Most African countries lacked an ade-

quate number of hydrologists at the time of gaining their independence and hydrological knowledge was scarce. Both local efforts and external assistwas scarce. Both local efforts and external assistance have sought to overcome these problems. The two most favored methods of rectifying the situation have been the sending of high-level hydrologists to African countries for specific tasks and the granting the fellowships to Africans for high-level training in developed countries, on the other hand. Both these approaches offer benefits for the persons involved. Less effort was directed toward leads training for hydrologial personnal. for the persons involved. Less effort was directed toward local training for hydrological personnel. The appropriate planning of hydrological training and education should be conceived as (1) defining a country's required number of hydrologists of different levels for the foreseeable period based on long-term development objectives, (2) planning the training facilities required in the country and taking steps for their realization, including external assistance, (3) seeking highest level hydrological education, including post-graduate training, in developed countries for a limited number of selected personnel. Setting un a staff of local hydrologists veroped countries for a innter number of selected personnel. Setting up a staff of local hydrologists using aid from developed countries is important. (See also W91-02288) (Author's abstract) W91-02293

POST GRADUATE COURSE IN HYDROLOGY AND HYDROGEOLOGY (FORMATION POST-UNIVERSITAIRE EN HYDROLOGIE ET HY-DROGEOLOGIE).

Ecole Inter-Etats d'Ingenieurs de l'Equipement Rural, Ouagadougou (Burkina Faso).

Rural, Ouggander Columnia 1227,

N: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 911-918, 2 append. English summa-

Descriptors: \*Africa, \*Civil engineering, \*Developing countries, \*Education, \*Geohydrology, \*Hydrology, Burkina Faso, Engineering personnel, Groundwater, Rural areas, Surface water, Water

Since 1984 the EIER (Ecole Inter-Etats d'Ingenieurs de l'Equipement Rural) has offered a 1-yr postgraduate course in water resources engineering at Ouagadougou, Burkina Faso. The course is inended for engineers with at least 2 yr professional experience in the water sector. Both surface water and groundwater engineering are included covering the following subjects: qualitative and quantitative assessment of surface and groundwater resources; planning, design, and follow-up of hydraulic structures (e.g., dams, river intakes, pumping stations, wells, and drillings); fitting of structures to their intended purpose; and technical and sanitary maintenance of structures. Theoretical lectures, tutorials, and experiments are combined with Since 1984 the EIER (Ecole Inter-Etats d'Ingentures, tutorials, and experiments are combined with hands on construction of works in connection with hands on construction of works in connection with contractors. Site visits and study tours are included in the course. Participating students come from different countries and have a wide range of background and professional experience. The course is divided in two equal parts dealing with surface water and groundwater. It is adapted to the students' diverse backgrounds. In 1988, CAMES granted the course an equivalence with a DESS (Diplome d'Etude Superieur Specialise). Staff is partly in-house within EIER and partly visiting staff from various African and European institutions. This course, which is supported by UNESCO (ANSTI) is intended to train about 10 specialists per year in Africa who are directly specialists per year in Africa who are directly involved in practical aspects of water resources engineering. (See also W91-02288) (Author's abstract) W91-02363

HYDROLOGICAL EDUCATION AT THE AGR-HYMET CENTRE (LA FORMATION EN HY-DROLOGIE AU CENTRE AGRHYMET).

DROIDGIE AU CENTIRE AGRITMEI).
Agrhymet Centre, Niamey (Niger).
H. A. Maiga.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouaga-

dougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 919-932. 1 fig, 2 tab, 9 ref. English

Descriptors: \*Civil engineering, \*Developing countries, \*Education, \*Niger, AGRHYMET, Agricultural hydrology, Geology, Hydrology, Instrumentation, Meteorology, Sahel, Training.

The Regional Training Center for Agrometeorology and Operational Hydrology in Niamey (Republic of Niger) is one of the rare institutions in Africa that has specialized in hydrological education. The Center forms part of the AGRHYMET project covering the nine CILSS (Comite Permanent Inter-Etats de Lutte contre Secheresse au Sahel) countries. The project was conceived to teach hydrology and hydrometeorology for use in agriculture and it has developed in three phases. Training in agrometeorology and hydrology always has been an important part of the project. Between 1975 and 1987, 198 students received diplomas: 91 in agrometeorology, 71 in hydrology, diplomas: 91 in agrometeorology, 71 in hydrology, and 36 in hydrometeorological instrumentation. Besides basic courses, specialized courses in agrometeorology and informatics have been offered, meteorology and informatics have been offered, particularly during the second project phase. Hydrological education is split into two branches, one for higher technicians, the other for civil engineers. The study programs include basic instruction and special hydrological subjects. The curriculum foresees theoretical lessons, written exercises, practical training, and field work. (See also W91-02288) (Author's abstract) W91\_02364

STATE WETLAND PROTECTION LEGISLA-TION AFFECTING FORESTRY IN THE NORTHEASTERN UNITED STATES.

Southern Forest Experiment Station, New Orle ans, LA.

W. C. Siegel, and T. K. Haines. Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 239-252, June 1990. 21 ref.

Descriptors: \*Environmental protection, \*Forest ecosystems, \*Forestry, \*Land use, \*Legislation, \*Resources management, \*Wetland forests, \*Wetlands, Agriculture, Policy making, Regulations.

A number of significant developments in wetland protection and water resource legislation have occurred in the United States in recent years that affect forestry operations, both at the federal and state levels. An historical review indicates that while control of water pollution and the protection of wetlands was first addressed in 1972 by the Federal Water Pollution Control Act Ammendments (FWPCA), to date, most forestry regulation in the eleven northeastern states is carried out in in the eleven northeastern states is carried out in response to specific situations and areas, rather than through state-wide programs. Until recently, most regulation was not very restrictive except in certain limited circumstances. Furthermore, many of the laws are conflicting, inconsistent, and overlapping, causing confusion among woodland owners and loggers. In some cases the requirements are so rigid and complex that forestry operations are also needlessly expensive. All indications point to the conclusions that nonpoint source water pollution prevention and wetland protection will continue as both important national and state priorities. As the northeastern states begin to address renewed efforts under Section 319 of the 1937 Amendments to the FWPCA, the forestry community in the northeast should be aware that 1987 Amendments to the FWPCA, the forestry community in the northeast should be aware that the current regulatory trend could be only the tip of the iceberg. It will be important, therefore, that forest landowners, woodland managers, and timber operators in the northeast work closely with law-makers in the development and modification of water resource and wetland protection legislation. Legislators and policy makers need to be informed of the potential effects of overly aggressive and poorly formulated statutes on forest management. They should also be made aware of the interacting and conflicting provisions of current federal, state and local water and wetlands laws affecting forest-overlands in these efforts will be essential if forest owners and managers do not continue to be

# Ecologic Impact Of Water Development—Group 6G

confronted with a labyrinth of inconsistent, confuscontrolled with a labyrinth of inconsistent, confusing, and overly restrictive regulations. Forest sector input will be crucial to retaining a reasonable operating environment while, at the same time, ensuring that water quality and wetlands are adequately protected. (D'Agostino-PTT) W91-02487

FEDERAL LEGISLATION AND WETLANDS PROTECTION IN GEORGIA: LEGAL FOUN-DATIONS, CLASSIFICATION SCHEMES, AND INDUSTRY IMPLICATIONS.

Georgia Univ., Athens. School of Forest Re-

Sources.
F. W. Cubbage, L. K. Kirkman, L. R. Boring, T.
G. Harris, and C. E. Deforest.
Forest Ecology and Management FECMDW, Vol.
33/3, No. 1/4, p 271-286, June 1990. 2 fig, 2 tab, 9

Descriptors: \*Environmental protection, \*Forestry, \*Land use, \*Legislation, \*Regulations, \*Wetland forests, \*Wetlands, Dredging, Federal jurisdiction, Fill permits, Georgia, Legal aspects, Per-

Federal legislation regarding wetland protection began with the enactment of the 1972 Amendments to the Federal Water Pollution Control Act. Sec-tion 404 of the Act states that any activities that deposit dredged or fill material in the nation's waters or wetlands would be subject to regulation by the U.S. Army Corps of Engineers which cur-rently determines permit requirements subject waters or wetlands would be subject to regulation by the U.S. Army Corps of Engineers which currently determines permit requirements subject to EPA review. All dredge-and-fill activities require permits, excepting rare specific cases, and other operations, such as road building and timber production, must follow best management practice guidelines for exemption. At the regional level, adequate classification methods are necessary to delineate those areas which warrant protection. In the southeastern states such as Georgia, such delineation adapted to west conditions, and the presence of water. To date, most forest operations in progress have not been seriously affected by the dredge-and-fill permit requirements. Much forest land, even in the southern coastal plain, would not be classed as wetlands under the Corps delineation methods. Some bottomland hardwoods, cypress swamps, and pocosins would fall within the wetlands definition. This constitutes about 10-20% of the total forest area in the South, but much of the lands are not viable for commercial timber production. Most commercial southern pine-forest types would not be classed as wellands under the Corps delineation. lands are not viousle for commercial timber produc-tion. Most commercial southern pine-forest types would not be classed as wetlands, and thus not subject to Section 404 regulation. In most southern states, federal wetlands regulations have affected only a fraction of the commercial timber-growing states, federal wetlands regulations have affected only a fraction of the commercial timber-growing operations. Several areas do, however, have potential for much greater effects. These include much of the Mississippi Delta, southern Louisiana, Florida, the Carolina pocosins, and other large swamps. If the pervasive national sentiment for preserving wetlands and vigorous enforcement by the Corps and EPA prevail, many of these lands will have to be managed in their natural state, or not at all. (D'Agostino-PTT) W91-02488

APPLICATION OF A DIGITAL GEOGRAPHIC DATA BASE TO IRRIGATION WATER RIGHTS MANAGEMENT.

Bureau of Reclamation, Denver, CO. Engineering

and Research Center.

and Research Center.
J. P. Verdin, M. P. Crane, and G. P. Lyford.
IN: Remote Sensing Applications for Consumptive
Use (Evapotranspiration). Papers Presented at 21st
Annual AWRA Conference and Symposium,
August 11-16, 1985, Tucson, Arizona. AWRA
Monograph Series No. 6, (1985). p 35-49, 9 fig, 3

Descriptors: \*Databases, \*Digital map data, \*Geopescriptors: "Jationses, "Ognati niap Juata, "Geo-graphic information systems," Ilrigation water, "Mapping, "Water resources management, "Water rights, Carson River, Computer programs, Data acquisition, Data interpretation, Hydrologic data collections, Nevada, Newlands Project, Remote sensing, Truckee River.

Located in west-central Nevada in the vicinity of the town of Fallon, the Newlands Project utilizes water from the Carson and Truckee Rivers to irrigate Nevada's most productive agricultural region. As a result of recent court decisions, the Bureau of Reclamation is responsible for developing operating criteria and procedures (OCAP) for the Newlands Project. A key provision of the OCAP is the annual establishment of the quantity of irrigation water diversions to the project. Annual diversions are based on the number of acres of land possessing legal water rights that are actually under irrigation. The specific entitlement per acre is dependent on whether land is designated as bench land or bottom land, a soil-type distinction. To facilitate the OCAP water allocation effort, a digital geographic database was developed by the Bureau's remote sensing section. Several critical information layers, including water righted lands, bench and bottom lands, and irrigation lands were entered into the database to portray conditions in the project area during the 1984 growing season. The information layers had as their sources both map and remote sensing data. Computer software was then used to derive section by section summaries of irrigated, water righted bench and bottom lands, and irrigated lands without water rights. A set of custom 7-1/2 min quadrangle maps and map overlays was produced with a computer-driven drum pen plotter to portray the information layers. Techniques for the rapid update of the irrigated lands information layer using satellite imagery and airborne video technology were also developed for application in subsequent years. (Author's abstract)

### 6F. Nonstructural Alternatives

SYSTEMS ENGINEERING APPROACH TO SOLUTIONS OF DROUGHT IN DEVELOPING COUNTRIES: THE CASE OF TANZANIA. New Tech International Inst., Dar es Salaam (Tan-

For primary bibliographic entry see Field 2A. W91-02361

#### 6G. Ecologic Impact Of Water Development

QUANTIFYING THE WATER BALANCE OF DRYLAND MILLET IN NIGER USING STATE OF THE ART EVAPORATION TECHNIQUES. Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 3F.

ENVIRONMENTAL AND AGRICULTURAL IMPLICATIONS OF DAM CONSTRUCTION IN THE NIGER VALLEY OF MALI.
Gesamthochschule Paderborn (Germany, F.R.).

H. K. Barth. H. K. Barth. In: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 857-869, 5 fig, 6 ref.

Descriptors: \*Dam effects, \*Deltas, \*Environmental impact, \*Mali, Farming, Fish, Floods, Flow augmentation, Gania floodplain, Interior Delta, Niger River, Rice, Sedimentation, Soil genesis,

The Niger/Bani drainage system is highly complex with regard to catchment area, discharge, and runoff characteristics. The most critical part of the river's drainage basin is the Interior Delta of the Niger. Due to extremely variable discharge rates and in conformity with its geomorphology, this vast delta is flooded seasonally with a significant shift in flooding phases between Ke-Macina and Tombouctou. Due to the high sensitivity of the complex hydrologic system of the delta region, building dams in the upstream parts of the river interferes seriously with the natural hydrologic conditions of the Interior Delta. In the Gania

floodplain (upper delta) the annual flooding occurs through a functioning network of old river chan-nels or, in most cases, by overflowing the system of embankments. Soil development is influenced by the sedimentation processes during floods. Vegeta-tional pattern reflects the differences in soils and flooding segions is differented the Dallace tional pattern reflects the differences in soils and flooding regime in different parts of the Delta. Although the Selingue Dam originally was de-signed to provide artificial floods, this could not be maintained, leading to failure to inundate vast areas of the floodplains over the last 5 yr. Growth of natural 'bourgou' grass was reduced substantially, with attendant reductions in feeding and breeding of fish. Rice production also fell. More than a million apone users imported by these effects. (See million people were impacted by these effects. (See also W91-02288) (Rochester-PTT) W91-02359

IMPACT OF HYDROLOGY ON HYDRAULIC PROJECTS IN BURKINA (IMPACT DE L'HY-DROLOGIE SUR LES PROJETS HYDRAULI-OUES AU BURKINA).

Ministry of Water Resources, Ouagadougou (Bur-kina Faso). Service de l'Hydrologie.

18. The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 870-888, 6 ref. English summary.

Descriptors: \*Burkina Faso, \*Dam effects, \*Dams, \*Drought, \*Water resources management, Artificial lakes, Data acquisition, Diversion, Economic aspects, Hydrologic data, Irrigation water, Monitoring, Regulations, Water quality control.

The threat of drought has forced Burkina Faso to The threat of drought has forced Burkina Faso to undertake intensive water resources development. Digging of dams has assumed great importance thanks to hydraulic organizations in place since the droughts of 1972-1974 and 1983-1984. This activity enabled irrigated cultivation on a large scale. There are 712 dams and 3 international great basins in the territory. These different hydraulic works have undoubtedly affected the natural hydrologic network of the country, through the profound changes brought about in the basin by the creation of artificial lakes and the diversion of rivers (totally to prestigate the profession of the profess or partially) to create water sources. This increasing number of projects necessitates a respect for scientific rules in their realization and necessitates strict respect for the water law in Burkina Faso, which was enacted on 1 April 1983 to regulate human intervention in water resources. The success of the projects and the effective administration cess of the projects and the entertive administration of water resources is strictly related to the quality and reliability of hydrologic data. This makes it essential to maintain and reinforce the hydrometric network. The administration of a hydrometric station is very difficult co pared to the financial resources available to the National Hydrologic Service. It is time that all users contribute materially to the acquisition of basic data for a better national hydrometric network administration in the common interest in order to safeguard water re-sources in the Sahel countries. (See also W91-02288) (Author's abstract) W91-02360

INFLUENCE OF IMPOUNDMENTS ON PHY-TOSESTON BIOMASS OF TWO SMALL LOW-LAND RIVERS-SKIERNIEWKA AND RAWKA

Polish Academy of Sciences, Lomianki. Inst. Ekologii.

For primary bibliographic entry see Field 2H. W91-02390

PRESENT SITUATION OF THE EUROPEAN FLOODPLAIN FORESTS.

Institute for Floodplains Ecology, Rastatt (Germa-For primary bibliographic entry see Field 4C. W91-02471

#### Field 6—WATER RESOURCES PLANNING

## Group 6G-Ecologic Impact Of Water Development

EDUCATED GUESSES: HEALTH RISK AS-SESSMENT IN ENVIRONMENTAL IMPACT STATEMENTS.

For primary bibliographic entry see Field 4C. W91-02508

WETLANDS AND GROUNDWATER: NEW CONSTRAINTS IN GROUNDWATER MAN-AGEMENT.

Universidad Complutense de Madrid (Spain). Dept. of Geodynamics. M. R. Llamas.

M. R. Llamas.
In: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 595-604, 2 fig, 13 ref.

Descriptors: \*Aquifer management, \*Case studies, \*Drainage effects, \*Groundwater management, \*Groundwater resources, \*Irrigation effects, \*Spain, \*Water resources management, \*Water supply development, \*Wetlands, Agricultural watersheds, Coastal areas, Ecological effects, Geohydrology, Groundwater potential, Irrigation, Legal aspects, Political aspects, Water demand, Wetland restrictation.

A great percentage of the wetlands in many countries has been destroyed over the last century through different causes, mainly because of drainage for agricultural reclamation. The role of groundwater in the behavior of wetlands has usually been recognized in a general way but detailed studies on the hydrogeology of wetlands are still scarce. Documented cause about the adverse in scarce. Documented cases about the adverse impacts of groundwater exploitation on wetlands are almost nonexistent. The problems in two wetlands in Spain were analyzed. Both sites have intense legal protection; however, the sizes, hydrogeologi-cal, and ecological characteristics and the legal and social aspects of both sites are somewhat different as are their respective degrees of deterioration. Nonetheless, the main cause of such deterioration Nonetheless, the main cause of such deterioration is the depletion of the water table caused by groundwater withdrawal for water supply and/or irrigation purposes. In the regions where there is a strong demand for water it is going to be difficult to conserve the ecosystems situated in discharge areas of aquifers containing fresh water owing to areas of aquifers containing fresh water owing to the economic value of groundwater. If these eco-systems are to be conserved, much more decisive prior action is required both in terms of the hydro-geological education of the government officials involved, politicians and the public in general, and also in terms of seeking financial compensation for those who are adversely affected by this conserva-tion. (See also W91-02672) (Author's abstract) W91-02722

GROUNDWATER FLOW AND QUALITY STUDIES IN SZIGETKOZ REGION, NORTH-WEST HUNGARY, Vizgazdalkodasi Tudomanyos Kutato Intezet, Bu-

Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).

L. Ujfaludi, and J. Maginecz.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 623-633, 5 fig, 10 ref.

Descriptors: \*Aquifer management, \*Dam effects, \*Danube River, \*Environmental impact, \*Groundwater management, \*Groundwater resources, \*Hungary, \*Water resources management, Case studies, Dispersivity, Environmental tracers, Flow models, Groundwater level, Groundwater movement, Groundwater quality, Infiltration, Model studies, Reservoirs, Surface-groundwater relations, Tracers, Tritium.

A dam currently being built in the Danube River in northwestern Hungary is being studied to determine its effects on the flow and quality of groundwater in its environment. The present pre-project state was examined first; for its simulation a model was developed which consists of a flow, a transport, and a chemical model. Regional dispersivity values, necessary for the transport simulation, were determined by detecting dispersive transport of the

natural tritium isotopes in the groundwater. Transport processes were simulated by the random walk method while chemical reactions were simulated using a previously-developed chemical model. The model-system calibrated for the pre-project state is to be used to predict groundwater quality for the post-project state. Simulation of the Szigtkoz groundwater quality is now at an intermediate stage. In spite of this, some previous results indicate that in the post-project condition, a reduction. stage. In spite of this, some previous results indi-cate that in the post-project condition, a reduction of discharge in the Danube main channel will occur. It causes a considerable change in the main direction of groundwater flow, while the quantity of water increases due to infiltration from the enlarged area of impounded water surface in the reservoir. A series of recharge facilities to compen-sate for the descending water table were tested by electrical analog. The results showed that a com-pined canal exstem would cause the elevation of electrical analog. The results showed that a com-bined canal system would cause the elevation of the water table to an acceptable level for agricul-ture and other activities. The water quality of the reservoir is expected to be different from that of the present Danube water. These effects together will probably result in an essential change of the groundwater quality. (See also W91-02672) (Fish-W91-02724

MULTIPLE DEMANDS ON WETLANDS.

Florida Univ., Gainesville. Dept. of Forestr For primary bibliographic entry see Field 2H. W91-02779

MODEL TO PREDICT AND ASSESS THE EF-FECTS OF GROUNDWATER WITHDRAWAL ON THE VEGETATION IN THE PLEISTO-CENE AREAS OF THE NETHERLANDS. Rijksinstituut voor Natuurbeheer, Leersum (Neth-

N. J. M. Gremmen, M. J. S. M. Reijnen, J. Wiertz, and G. van Wirdum.

Journal of Environmental Management JEVMAW, Vol. 31, No. 2, p 143-155, September 1990. 3 fig, 2 tab, 40 ref.

Descriptors: \*Groundwater management, \*Groundwater mining, \*Model studies, \*Pleistocene aquifers, \*The Netherlands, \*Water conservation, \*Water resources management, Flora, Plant populations, Policy making, Soil aeration, Soil analysis, Soil water, Species composition, Water

A model to predict the effects of groundwater withdrawal on the local flora was developed to provide a method to evaluate policy constraints regarding water use and water management in the Netherlands. It consists of five submodels, each dealing with a single or complex factors, namely: (1) soil moisture supply, (2) soil aeration, (3) soil nitrogen availability, (4) environmental dynamics, and (5) depth of open water. Plant species response to changes on the value of these factors was shown in the measurement of their moisture and nitrogen to changes on the value of these factors was snown in the measurement of their moisture and nitrogen content and also in their environmental stability classification. The use of this model requires data on the soil and hydrology of the area, species composition of the vegetation, and changes in groundwater depth and moisture availability regroundwater depth and moisture availability resulting from groundwater withdrawal. The end result is a list indicating the probability that the species in the area studied will disappear. This list would therefore serve as a basis to evaluate the impact of groundwater withdrawal when dealing with the conservation value of a study area. Sensitivity analysis of the model gave satisfactory results although comparison of field data and simulations tudies was unsatisfactory. This was attributed mainly to incomplete and inaccurate field data. (Medina-PTT) W91-02949

PROPOSED FRAMEWORK AND DATABASE FOR EIA AUDITING.

Murdoch Univ. (Western Australia). School of Bi-ological and Environmental Sciences. For primary bibliographic entry see Field 7B.

### 7. RESOURCES DATA

## 7A. Network Design

STREAMFLOW DATA AND SURFACE-WATER RESOURCE ASSESSMENT A QUANTITATIVE DEMONSTRATION OF NEED FOR ADEQUATE INVESTMENT IN DATA COLLECTION IN DEVELOPING COUNTRIES.

Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.

A. J. Adeloye. Aqua AQUAAA, Vol. 39, No. 4, p 225-236, August 1990. 6 fig. 5 tab, 34 ref.

Descriptors: \*Data acquisition, \*Data collections, \*Developing countries, \*Reservoir design, \*Statistical analysis, \*Streamflow data, \*Streamflow forecasting, \*Water resources data, \*Water resources development, \*Water supply, Cost analysis, Economic aspects, Monte Carlo method, Reservoirs, Stream discharge, Stream gages

Stream discharge, Stream gages.

In most developing countries the need to design reservoirs when little or no streamflow data exist for the purpose is commonplace, with the result that such designs are frequently in error and fail to deliver projected yields. A Monte Carlo simulation experiment has been performed to quantify the distortion due to short data record length associated with capacity estimates obtained from limited streamflow data records. The analysis was made more relevant to developing economies by limiting it to direct supply impounding reservoirs prevalent in such regions. Streamflow data from three European rivers were used to simulate a large number of equally likely synthetic time series of streamflow data, which were analyzed for the hydrological parameter of interest. The synthetic trace was extended to 1000 years to generate an estimate of the 'true' reservoir capacity, then broken down into sequences of shorter length (4 to 50 years). The resulting series of the hydrological parameter is then analyzed to determine its distribution, risk of failure, and other statistical characteristics. The simulation routing was done on a monthly time scale to accommodate both within-year and overthe-year storage requirements. The results show that streamflow data record length does have significant influence on reservoir capacity estimates; with a 6-year data record length does have significant influence on reservoir capacity estimates; with a 6-year data record length does have significant influence on reservoir capacity estimates; with a 6-year data record length does have significant influence on reservoir capacity estimates; with a 6-year data record length does have displaced to the capacity estimates; with a 6-year data record enter from a capacity estimates; with a 6-year data record length does have a gament of the results show the stream of the results show the results and the result that streamflow data record length does have sig-nificant influence on reservoir capacity estimates; with a 6-year data record the error in capacity estimates averages about 30%, and with a 20-year record the error in capacity estimates averages about 15%. The financial implications of these large errors should help convince politicians in the developing world to invest more in basic hydrolo-gical data collection. (Tappert-PTT) W91-02141

APPROXIMATION OF CONFIDENCE LIMITS ON SAMPLE SEMIVARIOGRAMS FROM SINGLE REALIZATIONS OF SPATIALLY CORRELATED RANDOM FIELDS.

Illinois State Water Survey Div., Champaign. Ground-Water Section. For primary bibliographic entry see Field 7C. W91-02187

AGRICULTURAL PESTICIDES AND GROUNDWATER IN NORTH CAROLINA: IDENTIFICATION OF THE MOST VULNERA-BLE AREAS.

North Carolina Water Resources Research Inst., Raleigh.

For primary bibliographic entry see Field 5G. W91-02245

TOWARDS A REGIONAL WATER RESOURCE STUDY OF ARID AND SEMI-ARID AFRICA. Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 2A.

HYDROLOGICAL NETWORK, DATA BANKS, AND TELETRANSMISSION (RESEAUX HY-

### Data Acquisition—Group 7B

DROLOGIQUES, BANQUES DE DONNEES IN-FORMATISEES ET TELETRANSMISSION). Office de la Recherche Scientifique et Technique Outre-Mer, Montpellier (France). For primary bibliographic entry see Field 7B. W91-02352

IMPACT OF CLIMATIC CHANGES ON SUR-FACE WATER RESOURCES IN WEST AND CENTRAL AFRICA (IMPACT DES CHANGE-MENTS CLIMATIQUES SUR LES RES-SOURCES EN EAU DE SURFACE EN AFRI-SOURCES EN EAU DE SURFACE EN AFRI-QUE DE L'OUEST ET CENTRALE: L'EXPER-IENCE DE L'OSTROM). Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Paris.

J. Sircoulon.

In: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 964-975, 4 tab, 30 ref. English sum-

Descriptors: \*Africa, \*Climatology, \*Drought, \*Network design, \*Sahel, \*Surface water, \*Water resources data, Climates, Data acquisition, Economic aspects, History, Hydrologic data, Institutional aspects, Low flow, Niger River, River flow, Runoff, Senegal River, Surface runoff.

Surface water resources in Africa exhibit great interannual fluctuations due to the climatic variations occurring in this area. The assessment of the resource encounters numerous problems in relation to the difficult conditions of operating the networks. to the difficult conditions of operating the networks, accessibility of measurement stations, and financial means. The historical growth of these networks is discussed. ORSTOM's commitment in the sahelian countries, sustained by the Inter-African Committee for Hydrologic studies, has made it possible to establish a basic understanding of hydrometeorological phenomena and useful syntheses. The drought of the last 20 yr is the most severe of the century. The water yields to the sahelian zone have fallen 40%. The major rivers, such as the Senegal and the Niger, have been affected dramatically, with very weak floods and severe low flows, whereas the runoff distribution on small sahelian watersheds seems to be unchanged, suggesting that the dry period favors increased surface runoff. (See also W91-02288) (Author's abstract) W91-02368

INVENTORY TECHNOLOGY: 'EBB TIDES', 'FLASH FLOODS', AND 'WHIRLPOOLS'.
Forest Service, Washington, DC. Timber Manage-

H G Lund Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 559-579, June 1990. 19 ref.

Descriptors: \*Data acquisition, \*Data storage and retrieval, \*Forest ecosystems, \*Forestry, \*Resources management, \*Wetland forests, \*Wetlands, Classification, Data interpretation, International agreements, Management planning, Remote sensing, Surveys.

Due to the advent of new information and technology, the present methods utilized for conducting forest resource inventories are currently being evaluated by the USDA Forest Service. There is a pressing need for more specific and effective data collection techniques, as well as more cost-effective methods, including coordinated inventories and data sharing. Some changes regarding information requirements, integrated inventories, planning and monitoring capabilities are already taking place as a result of remote sensing devices, computer technology and improved field techniques. This technology can ultimately provide improved resource inventories for the classification and delineation of all types of ecosystems, including forested wetlands. It is suggested that the policy affecting these resources must be managed on an international level in order to ensure the survival of forested wetlands. Four courses which should of forested wetlands. Four courses which should be considered are: (1) Take a holistic approach to resource inventories; (2) Develop an international

definition and classification system for wetlands; and (3) Have an international group champion the monitoring of forested wetlands on a global basis. (D'Agostino-PTT) W91-02302

TEMPORAL VARIABILITY OF WATER QUALITY AND THE IMPLICATIONS FOR MONITORING PROGRAMMES IN IRISH LIMESTONE AQUIFERS, Trinity Coll., Dublin (Ireland). Environmental Sciences Unit.

C. Coxon, and R. H. Thorn.

C. Coxon, and K. H. Inorn. IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washing-ton, DC. 1989. p 111-120, 4 fig. 2 tab, 8 ref.

Descriptors: \*Groundwater management, \*Groundwater pollution, \*Groundwater quality, \*Network design, \*Sampling, \*Water quality management, \*Water resources management, Aquifers, Geohydrology, Groundwater movement, Ireland, Karst hydrology, Limestone, Monitoring, Path of pollutants, Pollution load, Temporal distribution, Water pollution sources, Water sampling.

The first step in designing a groundwater sampling program must be to determine the degree of tem-poral variation, as the greater this is the more samples are required to obtain the same degree of poral variation, as the greater this is the more samples are required to obtain the same degree of precision. Contaminated sites show greater temporal variations; the degree of variation determined at clean sites may not be applicable to contaminated sites within the same hydrogeological setting. The hydrogeological situation must be determined, because temporal variability increases with the transition from intergranular flow to fissure flow. In the case of karst aquifers, the range of behavior is such that generalizations from one site to another should not be made. An investigation has been made of temporal changes in water quality in some Irish limestone aquifers. Twenty-two groundwater sources in aquifers ranging from intergranular flow in limestone sand and gravel aquifers to conduit/fissure flow in karst aquifers were sampled every two weeks for one year. The results show that the groundwater sources with the greatest water quality variability are either those that are contaminated or those situated in the mature karst aquifers. The results have clear implications for monitoring since they show that the usual guidelines for sampling groundwater are not necessarily appropriate in limestone aquifers. (See also W91-02672) (Fish-PTT)

EVALUATION OF REGIONAL FLOOD FRE-QUENCY ANALYSIS WITH A REGION OF IN-FLUENCE APPROACH.

Manitoba Univ., Winnipeg. Dept. of Civil Engineering. For primary bibliographic entry see Field 2E. W91-02856

## 7B. Data Acquisition

REMOTE SENSING APPLIED TO GLACIER SUPERVISION IN THE FRENCH ALPS (YEARS 1986, 1987 AND 1988)(TELEDETEC-TION APPLIQUEE AU SUIVI DES GLACIERS DES ALPES FRANCAISES (ANNEES 1986, 1987 ET 1999) ET 1988)).

oble-1 Univ. (France). Lab. de la Montagne

Alpine.
J. P. Dedieu, and L. Reynaud.
Houille Blanche HOBLAB, Vol. 1990, No. 5, p
355-358, 1990. 2 fig, 7 ref. English summary.

Descriptors: \*Alps, \*Glaciers, \*Glaciohydrology, \*Remote sensing, \*Satellite technology, France.

Satellite images enable changes in the volume of a glacier to be studied. Satellite images were used to study the St. Solin, Quirles, and Sarenne glaciers of Grandes Rousses. Results from seven French glaciers indicate a good homogeneity between changes in volume and the altitude of the firn line,

providing a record of the variations in volume over all of the French Alps. (King-PTT) W91-02051

GLACIAL MASS BALANCE DETERMINATION IN THE ACCUMULATION ZONE BY IN SITU MEASUREMENTS OF TCHERNOBYL RADIOACTIVITY (DETERMINATION DU BILAN GLACIAIRE EN ZONE D'ACCUMULATION PAR MESURE IN SITU DE LA RADIOACTIVITE DUE A TCHERNOBYL).

Laboratoire de Glaciologie et Geophysique de l'Environnement, Saint-Martin d'Heres (France). For primary bibliographic entry see Field 2C. W91-02052

TOXICITY TEST FOR WATER AND WASTE WATER: ALDEHYDE DEHYDROGENASE INHIBITION TEST IN CUVETS AND MICROTIFER PLATES (TOXIZITAETSTESTS FUER WASSER UND ABWASSER: KUEVETTENUM MIRROTITERPLATTENTEST MIT AL DEHYDDEHYDROGENASE).
Wasserforschung Mainz G.m.b.H. (Germany, F.R.).

For primary bibliographic entry see Field 5A. W91-02056

SORPTION LAYERS IMPREGNATED WITH AMMONIUM MOLYBDATE FOR THE THIN LAYER CHROMATOGRAPHY IN ORDER TO EVALUATE PHENOL CONTAMINATED WATERS (AMMONIUMMOLYBDATIMPAEGNIERTE SORPTIONSCHICHTEN FUER DIE DUENNSCHICHTEN TOER DIE BEURTEILUNG PHENOLKONTAMINIERTER

Kreiskrankenhaus Treuenbrietzin (German D.R.). For primary bibliographic entry see Field 5A. W91-02059

SOLUBLE FLUORESCENCE: EFFECTS ON CHLOROPHYLL DETERMINATION AT DIFFERENT SALINITIES.

Rhode Island Univ., Narragansett. Graduate School of Oceanography. For primary bibliographic entry see Field 2L. W91-02065

MEASURING EPILITHIC BACTERIAL PRO-DUCTION IN STREAMS. Guelph Univ. (Ontario). Dept. of Zoology. For primary bibliographic entry see Field 2H.

EFFECTS OF WATER ACIDITY, CALCIUM, AND ALUMINUM ON WHOLE BODY IONS OF BROOK TROUT (SALVELINUS FONTINALIS) CONTINUOUSLY EXPOSED FROM FRATILIZATION TO SWIM-UP: A STUDY BY INSTRUMENTIAL NEUTRON ACTIVATION ANALYSIS.

McMaster Univ., Hamilton (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5C.
W91-02104

SOIL WATER DIFFUSIVITY DETERMINA-TION BY A MODIFIED ONE-STEP OUTFLOW METHOD.

Nebraska Univ.-Lincoln. Dept. of Agronomy. For primary bibliographic entry see Field 2G. W91-02140

EFFECTS OF FLOW DISTURBANCES ON THE ACCURACY OF TURBINE-TYPE WATER METERS. P. Harrison

Aqua AQUAAA, Vol. 39, No. 4, p 250-257, August 1990. 8 fig, 3 tab, appendix.

Descriptors: \*Flow measurement, \*Pipe flow, \*Water metering, Design standards, Hydraulics, Performance evaluation, Testing procedures.

#### Field 7—RESOURCES DATA

### Group 7B-Data Acquisition

The accuracy of a water meter when installed in a pipe is affected by disturbances in the flow of water passing through it. Installing the meter in a sufficient length of straight pipe will eliminate the effects of the disturbance, but the necessary lengths effects of the disturbance, but the necessary lengths for particular disturbance patterns, and for the different meter types and sizes, are not known. A research program, initiated by the Eureau EU10 committee and given financial assistance by the Community Mureau of Reference of the European Community, was implemented to determine if existing meter installation stipulations were valid for modern turbine-type water meters. Meters tested were single jet meters, multi-jet meters, and Woltzenshiver meters. The tests were certified out by mann-type meters. The tests were carried out by eleven laboratories in five countries, and utilized eleven laboratories in five countries, and utilized eleven different water meters in seven sizes. In-line flow disturbance devices were developed and used by all the laboratories to create identical 'standardized' flow disturbances. The two types of disturbances studied were velocity profile distortion and swirl. The establishment of valid comparisons between each laboratory was based on the use of 'round-robin' tests on individual meters, and the tests carried out to investigate the effects of flow disturbances. Virtually all of the meters tested failed to comply with the installation provisions. The Committee considered that the straight lengths of pipe called for in the Document were already as long as was commercially practical, and that it was necessary to require manufacturers to supply new designs for water meters. (Tappert-PTT)

ANALYSIS OF THE IN SITU CONSTANT-HEAD PERMEABILITY TEST IN CLAYS.

McGill Univ., Montreal (Quebec). F. Tavenas, M. Diene, and S. Leroueil. Canadian Geotechnical Journal CG/JOAH, Vol. 27, No. 3, p 305-314, June 1990. 15 fig, 14 ref.

Descriptors: \*Clays, \*Data acquisition, \*Permeability, \*Permeability coefficient, \*Piezometric head, \*Soil tests, \*Soil water, Clogging, Finite element method, Mathematical analysis, Quebec,

The in situ measurement of soil permeability has become an important part of geotechnical engineering. Tests in boreholes and piezometers are often adversely affected by the possible remolding of the soil and clogging of the probe during installation. New self-boring equipment has made the execution of in situ constant-head tests in fine-grained soils simple and reliable. However, the theories used for the interpretation of constant-head tests in low-permeability soils still present some shortcomings, most notably a failure to properly account for the clay behavior or the effect of probe geometry. A finite element analysis of the constant-head test in clays was developed to evaluate the various expressions of shape factor published in the literature, and to provide a basis for extrapolating transient state observations to steady state conditions from which the permeability may be computed. A method was developed that determined an acceptable linear relationship for flow-time data and proposed a shape factor to account for vertical flow near the end sections of the probe in isotropic media. The resulting method of interpreting in situ permeability tests was applied to a series of field results obtained from a Champlain clay deposit. The field results confirm the finite element analysis and validate the method for interpreting constant-head tests. (Tappert-PTT) become an important part of geotechnical engineering. Tests in boreholes and piezometers are

FIELD FROST HEAVE MEASUREMENT AND PREDICTION DURING PERIODS OF SEA-

SONAL PROST.
Agriculture Canada, Ottawa (Ontario). Land Resource Research Centre.
For primary bibliographic entry see Field 2C.
W91-02150

METHODS FOR MEASURING THE SATURAT-ED HYDRAULIC CONDUCTIVITY OF TILLS. Norges Landbrukshoegskole, Aas. P. D. Jenssen.

Nordic Hydrology NOHYBB, Vol. 21, No. 2, p 95-106, 1990. 3 fig, 1 tab, 36 ref.

Descriptors: \*Data acquisition, \*Glacial sediments, \*Groundwater movement, \*Hydraulic conductivity, \*Saturated flow, \*Till, Geologic fractures, Sediment sorting, Sedimentation.

The texture of tills excludes many of the traditional methods for measurement of the saturated hydraulic conductivity (K). The hydraulic conductivity is scale dependent, and for massive, relatively homogeneous till a representative sample volume of 10,000 to 100,000 cubic centimeters is suggested; for very heterogeneous sediments and sediments with large fracture spacing larger samples may be needed. There are no ideal methods for measuring K in till and type of method and equipment should needed. There are no ideal methods for measuring K in till and type of method and equipment should be carefully selected. The main sources of uncertainty in laboratory methods include representativity of the sample (due to size, structure, and density) and interfacial flow along the tube/sediment interface. Field methods are considered to give better estimates of K than laboratory or cor-relative methods because the test sediment is less relative methods because the test sediment is less disturbed and a larger volume is utilized. Studies comparing and evaluating different test methods for use in till are few, and comparative studies should be carried out. In the unsaturated zone a variant of the inverse auger hole method using a constant head and a lined pit is recommended over cylinder infiltrometers. In the saturated zone meascylinder infiltrometers. In the saturated zone measurements in dug wells are considered the most representative method. A greater number of methods are suitable for use in clayey/silty till than in sandy/gravelly till, due to the higher stone content in the latter. Correlative methods can only be used for very approximate predictions of the saturated hydraulic conductivity in till. (Tappert-PTT) W91-02166

UNSATURATED HYDRAULIC CONDUCTIVI-TY DETERMINED BY THE HOT AIR METHOD FOR SOME DANISH TILL SOILS. Department of Soil Tillage, Soil Physics and Irrigation, Tinglev (Denmark).
For primary bibliographic entry see Field 2G.
W91-02169

**EXAMS 2: EXPOSURE ANALYSIS MODELING** 

Bayreuth Univ. (Germany, F.R.). Chair of Ecological Chemistry and Geochemistry. K.-W. Shramm.

Toxicological and Environmental Chemistry TXECBP, Vol. 26, No. 1/4, p 73-82, 1990. 2 fig, 1

Descriptors: \*Computer models, \*Computer programs, \*EXAMS 2 model, \*Model studies, \*Path of pollutants, \*Population exposure, \*Toxicology, Aquatic environment, Limnology, Organic compounds, Pollution load, Water quality.

EXAMS 2 was developed for rapid evaluation of the behavior of organic chemicals in aquatic eco-systems. EXAMS 2 inputs include the chemistry and relevant transport and physicochemical prop-erties of the compound and the ecosystem. Model outputs are (1) expected environmental concentra-tions, (2) the fate of chemicals due to transport and isons, (c) the rate of enemicals due to transport and transformation processes, and (3) the persistence of chemicals in the system once chemical loadings terminate. The program is interactive and allows the user to define and store the properties of chemicals and the environment. Loadings, transport, and transformations are combined into a set of differential equations assuming consequences. port, and transformations are communed into a second differential equations assuming conservation of mass. Chemical mass entering from and leaving to the environment is treated as the algebraic sum of the environment is treated as the environment is treated as the environment is treated as the algebraic sum of external loadings, transport processes that export chemicals from the system, and transformation processes that convert chemicals to their transformation products. Water bodies can be made up of a set of distinct environmental zones, such as benthic, epilimnic, hypolimnic, and littoral compartments. EXAMS 2 accepts standard water quality and limnological parameters. The program will support up to 999 environmental compartments. Although EXAMS 2 is combined with terrestrial models the present version is not able to model

chemical concentrations in the air above the water surface. Thus, simple contamination of the water by the atmosphere cannot be modeled. (Author's tract) W91-02174

DETECTION OF ORGANOPHOSPHORUS PESTICIDE DETOXIFYING BACTERIAL COLONIES, USING UV-PHOTOGRAPHY OF PARATHION-IMPREGNATED FILTERS

Texas A and M Univ., College Station. Dept. of Biochemistry and Biophysics.

For primary bibliographic entry see Field 5B. W91-02200

EVALUATION OF THE CONTINUOUS SEIS-MICREFLECTION METHOD FOR DETER-MINING THE THICKNESS AND LITHOLOGY OF STRATIFIED DRIFT IN THE GLACIATED

Geological Survey, Hartford, CT. Water Resources Div.

In: The Northeast Glacial Aquifers. Regional Aq-uifer Systems of the United States. Papers present-ed at AWRA Symposium on Monitoring, Model-ing, and Mediating Water Quality, May 17-20, 1987, Syracuse, New York. AWRA Monograph Series No. 11, 1988. p 63-82, 13 fig, 1 tab, 24 ref.

Descriptors: \*Continuous seismic reflection, \*Data Descriptors: "Continuous seismic reflection, "Data acquisition, "Geohydrology, "Geophysical surveys, "Glacial aquifers, "Groundwater resources, "Lithology, "Regional Aquifer-Systems Analysis, "Stratified drift, Aquifers, Connecticut, Connecticut River, Geophysics, Maine, New Hampshire, River sediments, Saco River, Seismic reflection.

Continuous seismic-reflection methods have been used for several years in shallow water to determine depth to bedrock or thickness of alluvial and glacial deposits. Acquisition of data in narrow, shallow waterways has been difficult, but recent development of improved sound sources and data collection with the enabled collection of high development of improved sound sources and data collection methods has enabled collection of high quality field data, even in rivers only a few feet deep and a few hundred feet wide. Evaluation of data collected at localities where extensive drill hole control was available and under variable field conditions has shown that the results of this technique are highly dependent on site conditions. Where the riverbed sediments and the glacial drift are primarily fine grained, detailed depositional features of the drift can be detected. Where the riverbed sediments and the glacial drift are primarily fine grained, detailed depositional features of the drift can be detected. Where the riverbed sediments and the glacial drift are primarily fine grained, detailed depositional features of the drift can be detected. Where the reatures of the crift can be detected, where the riverbed sediments and the glacial drift are primar-ily coarse grained, however, only major strati-graphic boundaries, such as the stratified drift/till or drift/bedrock contacts, can be detected. In sevor all localities on the Connecticut River in Connecticut, and on the Saco River in maine and New Hampshire, the distribution of coarse-grained and fine-grained stratified drift, thick till, and bedrock, delineated from seismic-reflection records, agreed closely with nearby drill hole data. Along the Farmington River in Connecticut, very thick finegrained stratified drift deposits overlying bedrock were initially delineated by continuous seismic-reflection methods and subsequently verified by test drilling. (See also W91-02280) (Author's abstract) W91-02284

CONTINUOUS SEISMIC-REFLECTION PRO-CUNINGUES SEISMIC-REFLECTION PRO-FILING OF GLACIAL DRIFT ALONG THE SUSQUEHANNA, CHEMUNG, AND CHEN-ANGO RIVERS, SOUTH-CENTRAL NEW YORK AND NORTH-CENTRAL PENNSYLVA-

Geological Survey, Albany, NY. Water Resources

R. J. Reynolds, and J. H. William

In: The Northeast Glacial Aquifers. Regional Aquifer Systems of the United States. Papers presented at AWRA Symposium on Monitoring, Modeling, and Mediating Water Quality, May 17-20, 1987, Syracuse, New York. AWRA Monograph Series No. 11, 1988. p 83-103, 9 fig. 1 tab, 32 ref.

## Data Acquisition—Group 7B

Descriptors: \*Chemung River, \*Chenango River, \*Continuous seismic reflection, \*Data acquisition, \*Geohydrology, \*Geophysical surveys, \*Glacial quifers, \*Glacial drift, \*Groundwater resources, \*Regional Aquifer-Systems Analysis, \*Susquehanna River, Aquifers, Geophysics, New York, Pennsylvania, Sand, Silt, Stratigraphy, Surveys.

Continuous, high-resolution seismic-reflection pro-filing was used to define the stratigraphy of glacial drift along reaches of the Susquehanna, Chemung, and Chenango rivers in south-central New York nung was used to define the stratigraphy of glacial drift along reaches of the Susquehanna, Chemung, and Chenango rivers in south-central New York and north-central Pennsylvania as part of an investigation into the application of continuous seismic-reflection profiling to studies of glacial valley aquifers. Approximately 18 miles of the Susquehanna and Chemung Rivers between Waverly, NY, and North Towanda, PA, were surveyed, along with approximately 9.5 miles of the Susquehanna and Chenango Rivers near Binghamton and Endicott, NY. Surveys conducted in areas where the stratigraphic section consists chiefly of lacustrine silt and clay beneath thin deposits of gravelly alluvium and outwash achieved excellent signal penetration and defined in detail the upper surface of glacial deposits beneath the silt and clay as well as the underlying bedrock surface. From Waverly, NY, to North Towanda, PA, where this stratigraphy is typical, the surveys revealed two types of lacustrine deposits—a thick upper unit of laminated silt and clay that is virtually reflection free, and a discontinuous basal lacustrine unit of interbedded fine sand and silt that displays a draped, parallel-bedded structure over till or ice-contact deposits. Surveys conducted in areas where the stratigraphic section consists predominantly of coarse-grained outwash or ice contact deposits with little or no interbedded lacustrine material were characterized by poor signal penetration and multiple reflections from the river bottom or shallow sub-bottom. This was the general case with surveys conducted along the Susquehanna River from Endicott to Binghamton and along the lowest reach of the Chenango River Signal penetration and resolution increased markedly in an adjacent upstream reach of the Chenango River valley, where the stratigraphic section includes thick, fine-grained presence or absence of multiple reflections appear to be a result of the relative grain size and thickness of the glacial drift. (See also W91-02280) (Author's abstract) stract) W91-02285

USE OF OXYGEN-18 AND DEUTERIUM MASS-BALANCE ANALYSIS TO EVALUATE INDUCED RECHARGE TO STRATIFIED-DRIFT AQUIFERS. Geological Survey, Albany, NY. Water Resources

For primary bibliographic entry see Field 2F. W91-02287

ELECTRONICS AND INFORMATICS FOR THE ACQUISITION OF HYDROMETEORO-LOGICAL DATA: A GREAT TOOL FOR WATER RESOURCE MANAGEMENT IN THE SAHEL (ELECTRONIQUE ET INFORMATI-QUE POUR L'ACQUISITION DES DONNEES HYDROMETEOROLOGIQUES, UN OUTIL PRODIGIEUX POUR LA GESTION DES RESSOURCES EN EAU DANS LE SAHEL). Laboratoire General de Recherches, Brussels (Beleium)

E. Iliman.
IN: The State-of-the-Art of Hydrology and Hydrogology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 202-210, 2 fig. English summary.

Descriptors: \*Africa, \*Computers, \*Data acquisition, \*Hydrologic data, \*Meteorological data collection, Automation, Climates, Cost analysis,

Electronic and informatic techniques were developed for the acquisition of hydrometeorological data. These techniques have proven effective in a number of countries and could contribute to better and more rational water management in the Sahe-

lian countries. Two techniques are employed: 'off-line' and 'on-line.' In the off-line system, data on temperature, relative humidity, insolation, water level, rainfall, and wind speed and direction are recorded by a portable data acquisition instrument, which can be connected by RS-232 cable for trans-ferring data to a central processing leastion. In the which can be connected by RS-232 cable for transferring data to a central processing location. In the on-line system, data are transmitted to a relay, which routes the data to a central station (PC-compatible or Macintosh microcomputer). Considerable improvements in the economical use of resources may be anticipated from the use of these techniques. (See also W91-02288) (Rochester-PTT) W91-02303

REVIEW OF WATER RESOURCES INVESTI-GATION AND DEVELOPMENT USING SAT-ELLITE REMOTELY SENSED DATA OF THE NAZINGA GAME AREA, BURKINA FASO.

Council for Scientific and Industrial Research, Kumasi (Ghana). Building and Road Research

Inst.
D. O. K. Kuma.
D. O. K. Kuma.
D. The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 211-221, 5 fig, 17 ref.

Descriptors: \*Arid lands, \*Burkina Faso, \*Remote sensing, "Satellite technology, "Semiarid lands, "Water resources development, Aerial photogra-phy, Damsites, Nazinga Game Reserve, Sissili River, Site selection.

River, Site selection.

The Nazinga Game Reserve is situated along the Sissili River, between Po and Leo in the Republic of Burkina Faso. The ranch aims to contribute to the development of meat production within the Sahel countries and to teach the local population the advantages of animal conservation and environmental protection. Recent applications of aerial photographs and satellite remotely sensed data for identifying and locating potential dam sites and natural impoundment areas are reviewed. These reservoirs are intended to provide adequate water supply for game and wildlife within the ranch area. Aerial photographs and satellite remotely sensed Landsat (MSS) and SPOT images are useful for the overall assessment of surface water movement and planning and development of water impoundment within the Nazinga game reserve area and in the arid/semi-arid zones in particular. Aerial photographs and satellite remotely sensed data are useful sources of information for inventorying of surface water potential and the selection of dam sites where climatic and terrain factors favor the use of remotely sensed data. (See also W91-02288) (Rochester-PTT)

QUANTIFYING THE WATER BALANCE OF DRYLAND MILLET IN NIGER USING STATE OF THE ART EVAPORATION TECHNIQUES. Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 3F. W91-02316

INVESTIGATION OF GROUNDWATER RE-CHARGE MECHANISMS IN BURKINA FASO. Vrije Univ. Amsterdam (Netherlands). Inst. voor Aardwetenschappen. For primary bibliographic entry see Field 2F. W91-02320

EXPLORATION OF KARSTIFIED JOINTS IN PRECAMBRIAN LIMESTONE AQUIFERS OF THE GONDO PLAIN (MALD) WITH ELECTROMAGNETIC HORIZONTAL-LOOP METHODS (LOCALISATION DES FRACTURES KARSTIFIEES DES CALCAIRES PRECAMBRIENS DANS LA PLAINE DU GONDO (MALI) PAR LA PROSPECTION ELECTROMAGNETIQUE RIPOLE. BIPOLE).

Neuchatel Univ. (Switzerland). Center of Hydrolo-

gy. For primary bibliographic entry see Field 2F. W91-02321

ELECTRIC METHOD IN VILLAGE HYDRAU-LIC PROJECTS IN BENIN: THE CASE OF CRYSTALLINE FORMATIONS (GRANITE-SANDSTONE) (LA METHODE ELECTRIQUE EN HYDRAULIQUE VILLAGEOISE: CAS DES FORMATIONS CRISTALLINES (GRANITE-

Universite Nationale du Benin, Cotonou, Dept. de Physique. For primary bibliographic entry see Field 2F.

W91-02322

PROSPECTING FOR AQUIFER FRACTURES IN THE CRYSTALLINE BASEMENT BY SOIL RADON ANALYSIS (PROSPECTION DES FRACTURES AQUIFERS DU SOCLE CRISTALLIN PAR DOSAGE DU GAZ RADON CONTENU DANS LE SOL).

Bureau de Recherches Geologiques et Minieres, Orleans (France).

For primary bibliographic entry see Field 2F. W91-02324

GEOPHYSICAL PROSPECTING FOR GROUND WATER EXPLORATION IN DISCONTINUOUS AQUIFERS FOR RURAL WATER SUPPLY PROJECTS IN THE SAHEL C.M. Consulting and Management, Rome (Italy). For primary bibliographic entry see Field 2F. W91-02325

NEW INSTRUMENTS FOR ELECTRICAL AND AUDIOMAGNETOTELLURIC PROSPECTING (CARACTERISTIQUES DES EQUIPEMENTS MODERNES DE PROSPECTION GEOPHYSI-QUE PAR METHODS ELECTRIQUE OU AU-DIOMAGNETOTELLURIQUE).

Bureau de Recherches Geologiques et Minieres, Orleans (France).

J. Bernard, and P. Valla.

J. Bernard, and P. Valla.

In: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 456-467, 8 fig. English summary.

Descriptors: "Aquifers, "Data acquisition, "Geophysical exploration, "Groundwater mining, "Measuring instruments, Computers, Conductivity, Electrical properties, Geologic fractures, Magnetism, Rock properties, SAMTEC 1, SAMTEC 2.

Geoelectrical methods are widely used in ground-water investigations, both in crystalline basements and sedimentary formations. These methods are successful because the electrical conductivity of successful because the electrical conductivity of rocks depends on their water content. In the field of direct current methods, the recent improvement in electronic techniques have lead to a new generation of microprocessor-controlled resistivity meters yielding high quality measurements, displaying the apparent resistivity values directly at the end of the measurement, and capable of storing data in an internal memory. Two field applications described here illustrate the use of electrical methods in croundwater investigations. (1) the search for fractional data of the control of the internal memory: I wo near applications described here illustrate the use of electrical methods in groundwater investigations: (1) the search for fracture zones in a crystalline basement using a profiling procedure, and (2) the detection of an aquifer layer at depth using a sounding procedure. For audiomagnetotelluric methods, in which natural currents induced in the ground are detected by measurement of electrical and magnetic components, the Bureau de Recherches Geologiques et Minieres (Orleans, France) has developed two receivers: SAMTEC 1 and SAMTEC 2. Their quality of measurement and ease of use now permit this method to be used in the detection of deep aquifer layers in situations where the use of long-line, direct-current conventional sounding would require high survey costs. (See also W91-02288) (Author's abstract) W91-02326

GEOPHYSICAL RECONNAISSANCE IN A FIS-SURED STRUCTURE: EXAMPLE IN LIP-TAKO, REP. NIGER (RECONNAISSANCE

#### Field 7—RESOURCES DATA

### Group 7B-Data Acquisition

GEOPHYSIQUE EN MILIEU FISSURE: EXEM-PLE AU LIPTAKO, REP, NIGER). Niamey Univ. (Niger). For primary bibliographic entry see Field 2F. W91-02327

GEOPHYSICAL METHODOLOGY APPLIED TO RURAL WATER SUPPLY IN BEDROCK ENVIRONMENT: PRELIMINARY RESULTS (METHODOLOGIE GEOPHYSIQUE APPLI-QUEE A L'HYDRAULIQUE VILLAGEOISE EN ZONE DE SOCLE: RESULTATS PRELIMIN-AIRES)

Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. de Geophysique. For primary bibliographic entry see Field 2F. W91-02328

GROUNDWATER RESOURCES IN A POORLY TRANSMISSIVE SANDSTONE IN A SEMI-ARID ENVIRONMENT: 2. REGIONAL INVESTIGATION OF GEOLOGICAL STRUCTURES.

TIGATION OF GEOLOGICAL STRUCTURES. Sveriges Geologiska A.B., Lulea (Sweden). B. Mannstrom, J. Bromley, L. Carlsson, A. Jamtlid, and D. Nisca.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 540-548, 2 fig. 8 ref.

Descriptors: "Botswana, "Geohydrology, "Geo-physical exploration, "Groundwater resources, "Remote sensing, "Sandstones, "Semiarid lands, Aerial surveys, Aquifers, Kalahari Desert, Region-al analysis, Tectonics.

The eastern end of the Kalahari Desert (Botswana) is a sand-covered plateau devoid of any permanent surface water. The region has a mean annual rainfall of 447 mm and a yearly potential evapotranspiration estimated at more than 1220 mm. The main aquifer is the Ntane (formerly Cave) sand-stone formation. The regional geological structure of this sandstone aquifer covered by 60 m of Kalahari sand was investigated by a low-level (average altitude 20 m a.g.s.) airborne geophysical survey comprising magnetic and electromagnetic measurements. The results exceeded all expectations. Geological structures such as graben, horsts, dikes, and faults were identified easily. The key to the success of the approach lay in the presence of magnetic units covering the aquifer and intruding below the Kalahari sand. The results enable those areas suitable for future groundwater investigation to be The eastern end of the Kalahari Desert (Botswana) Kananar sand. I he results enable those areas suitable for future groundwater investigation to be identified with certainty. In such a structurally complex area, surface geophysical studies would have furnished a much more crude and uncertain picture. (See also W91-02288, W91-02332, and W91-02334) (Rochester-PTT)

UTILIZATION OF THE ARGOS SYSTEM WITHIN THE FRAMEWORK OF THE HYDROMETRIC NETWORK OF BENIN (JUTILI, SATION DU SYSTEME ARGOS DANS LE CADRE DU RESEAU HYDROMETRIQUE BENINOIS).

BENITUIS), Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Niamey (Niger). Mission ORSTOM au Niger.

Mission ORSTOM au Niger.
G. Ale, and L. Le Barce.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 627-635, 1 ref. English summary.

Descriptors: \*Benin, \*Data acquisition, \*Hydrologic data, \*Satellite technology, \*Telemetry, ARGOS System, Performance evaluation.

Within the framework of classical hydrometric within the framework of classical hydrometric networks, data collection necessitates frequent visits for maintenance and calibration of the sta-tions. The rapid diffusion of data is hampered by the time needed for its evaluation and transforma-tion to conform to automation requirements as well

as its critical assessment. Benefitting from the ARGOS installations combined with the OCP and HYDRONIGER projects, the Hydrological Service of Benin decided to install an automated data ice of Benin decided to install an automated data gathering and transmission system throughout the country. Measuring instruments and teletransmission devices are mounted on ARGOS buoys. Data are transmitted to an ARGOS satellite and from there to a receiving station in Cotonou. The teletransmitted data are fed automatically into the data bank and the results can be made available to users much more rapidly. The great stability of the buoys and the possibility of observing their operation from a great distance permits a considerable extension of the interval between visits. The time tent in touring the hydrologic network has been extension of the interval between visits. The time spent in touring the hydrologic network has been reduced to 84 days/yr compared to 222 days/yr under the previous system. (See also W91-02288) (Author's abstract) W91-02340

INFLUENCE OF CONTINENTAL RIFTING ON THE HYDROGEOLOGY OF THE BAHI DRAINAGE BASIN, DODOMA PROVINCE, CENTRAL TANZANIA.

Cooperative Inst. for Research in Environmental Science, Boulder, CO. Center for the Study of Earth from Space.
For primary bibliographic entry see Field 2F.
W91-02342

STUDY OF PIEZOMETRIC DEPRESSIONS BY ENVIRONMENTAL ISOTOPES: FIRST DATA ON EXAMPLES IN MALI (ETUDE DES DE-PRESSIONS PIEZOMETRIQUES PAR LES ISOTOPES DE L'ENVIRONNEMENT: PRE-RES DONNEES SUR DES EXEMPLES AU MALD.

Projet AIEA, Dakar (Senegal). For primary bibliographic entry see Field 2F. W91-02343

HYDROLOGICAL NETWORK, DATA BANKS, AND TELETRANSMISSION (RESEAUX HY-DROLOGIQUES, BANQUES DE DONNEES IN-FORMATISEES ET TELETRANSMISSION). Office de la Recherche Scientifique et Tecl Outre-Mer, Montpellier (France).

Outre-Mer, Montpelher (France).

B. Pouyaud.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 783-790, 4 ref. English summary.

Descriptors: \*Africa, \*Data acquisition, \*Data processing, \*Hydrologic data, \*Network design, \*Satellite technology, \*Water resources development, ARGOS System, Hydrologic budget, ME-TEOSTAT, Telemetry.

The systematic collection of hydrological data in reference stations of a base hydrometric network permits the evaluation of surface water resources permits the evaluation of surface water resources and their annual variations. An exact knowledge of the hydrologic balance of flow maxima and minima is essential for each water resource development. Whatever the nature of the project (e.g., hydropower, water supply for agriculture, urban water supply, bridges, railways, or streets), the adequacy of the existing network needs to be checked to be sure it meets requirements. Systems such as ARGOS and METEOSTAT use teletransission via satellite to communicate hydrologic sucn as ARGOS and METEOSTAT use teletransmission via satellite to communicate hydrologic data. The hydrologic data is collected by networks of sensors affixed to buoys and transmitted to satellites four to six times a day. From the satellites, the data is transmitted to central receiving stations. (See also W91-02288) (Rochester-PTT) W91-02352

TELETRANSMISSION OF HYDROLOGICAL DATA WITHIN THE FRAMEWORK OF THE PROGRAMME TO COMBAT ONCHOCERCIASIS (TELETRANSMISSION DES DONNEES HYDROLOGIQUES DANS LE CADRE DU PROGRAMME DE LUTTE CONTRE L'ON-CHOCERCOSE).

Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Lome (Togo). Centre ORSTOM du Togo.

Centre ORSTOM du Togo.
J. C. Bader, L. Le Barbe, and E. Servat.
IN: The State-of-the-Art of Hydrology and Hydrogology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 791-799, 1 fig, 2 ref. English summa-

Descriptors: \*Africa, \*Data acquisition, \*Human diseases, \*Hydrologic data, \*Network design, \*On-chocerciasis, \*Satellite technology, \*Telemetry, ARGOS System, Computer programs, Flood forecasting, Insecticides, Model studies, Public health, World Health Organization.

World Health Organization.

A World Health Organization program for onchocerciasis control, Onchocerciasis Control Program (OCP), was launched in 1975 in West Africa. Insecticides were sprayed on rivers where vector larvae (Simulium damnosum) reside. About 3,000 to 15,000 km are being treated weekly. To make the campaign efficient without ecological damage it is necessary to know the river discharge at the moment of its treatment. After a pilot study in northern Togo, the OCP decided to employ the ARGOS satellite system in the data acquisition stage. A network of 80 instrument buoys and 2 independent receiver stations has been established. It also was necessary to establish methods for following precisely the propagation of floods and for forecasting the discharge between two buoys and between two messages transmitted. The network and the software used for short-term forecasting of discharge are described. Different forecasting of discharge are described. Different forecasting models have been used with this system, E. G. the propagation model (tested with the pilot network in northern Togo), an autorecessive model (also tested on the data from northern Togo) and a model based on the decline in river level. (See also W91-02288) (Rochester-PTT) W91-02353 W91-02353

INTEGRATED APPROACH FOR THE EVAL-UATION OF GROUNDWATER RESOURCES: A CASE STUDY IN YATENGA (APPROCHE IN-TEGREE POUR L'EVALUATION DES RES-SOURCES EN EAU SOUTERRAINES: ETUDE DE CAS AU YATENGA). Ministry of Water Resources, Ouagadougou (Bur-

kina Faso). For primary bibliographic entry see Field 2F. W91-02356

IMPACT OF HYDROLOGY ON HYDRAULIC PROJECTS IN BURKINA (IMPACT DE L'HY-DROLOGIE SUR LES PROJETS HYDRAULI-QUES AU BURKINA).

Ministry of Water Resources, Ouagadougou (Burkina Faso), Service de l'Hydrologie.
For primary bibliographic entry see Field 6G. W91-02360

MEASUREMENT AND CALCULATION OF DINITROGEN FIXATION IN WATER BODIES. Humboldt-Univ. zu Berlin (German D.R.). Sektion Biologie.
For primary bibliographic entry see Field 2K.

LIQUID CHROMATOGRAPHY-MASS SPEC-TROMETRY: AN EMERGING TECHNOLOGY FOR NONVOLATILE COMPOUNDS. Environmental Protection Agency, Cincinnati, OH. Chemistry Research Div. For primary bibliographic entry see Field 5A. W91-02417

PYROLYSIS-GC-MS FOR INVESTIGATING HIGH-MOLECULAR-WEIGHT THM PRECUR-SORS AND OTHER REFRACTORY ORGAN-ICS.

Centre de Recherche Lyonnaise des Eaux - Degremont, Le Pecq (France).

# Data Acquisition—Group 7B

For primary bibliographic entry see Field 5F. W91-02418

SAMPLING INTENSITY AND SPECIES RICH-NESS: EFFECTS ON DELINEATING SOUTH-WESTERN RIPARIAN PLANT COMMUNI-

TIES.

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab. For primary bibliographic entry see Field 2H. W91-02492

PC-BASED ANALYTICAL STEREOPLOTTER FOR WETLAND INVENTORIES: AN EFFI-CIENT AND ECONOMICAL PHOTOGRAM-METRIC INSTRUMENT FOR FIELD OFFICES. Norges Landbrukshoegskole, Aas. Inst. for Geore-sources and Pollution Research.

W. S. Warner.
Forest Ecology and Management FECMDW, Vol. 33/3, No. 1/4, p 571-581, June 1990. 3 fig, 1 tab, 18

Descriptors: \*Aerial photography, \*Data acquisi-tion, \*Instrumentation, \*Mapping, \*Photogramme-try, \*Surveys, \*Wetlands, Analytical methods, Computers, Data interpretation, Land manage-

Aerial photography is one of the most valued sources of information for wetland identification and inventory. Highly flexible photogrammetric systems, controlled entirely by PC technology, are currently available to collect primary data and make 3-dimensional measurements directly from the photographs. This study demonstrates the particular suitability of the PC-based analytical plotter, the Carto API90. It is simple to use, low in cost (US \$30,000), accurate (20 microns), flexible to operate (from simple 3-D measurements to GIS data entry), compatible with available software packages and portable for easy installation. This analytical stereoplotter for wetland inventories is an efficient and economical instrument for field office use. (D'Agostino-PTT) W91-02503

CLASSIFICATION OF MANGROVE FOREST BY USING 1:40,000-SCALE AERIAL PHOTO-GRAPHS.

Pertanian Malaysia Univ., Serdang. Faculty of Forestry. For primary bibliographic entry see Field 2H. W91-02504

USE OF HIGH-ALTITUDE AERIAL PHOTOG-RAPHY FOR INVENTORYING FORESTED WETLANDS IN THE UNITED STATES. Fish and Wildlife Service, Newton Corner, MA. For primary bibliographic entry see Field 2H. W91-02505

SYNOPTIC INVENTORY OF RIPARIAN ECO-SYSTEMS: THE UTILITY OF LANDSAT THE-MATIC MAPPER DATA.

ental Monitoring Systems Lab., Las Vegas, NV. For primary bibliographic entry see Field 2H. W91-02506

BINDING OF TRIAZINE HERBICIDES TO ANTIBODIES IN ANHYDROUS ORGANIC SOLVENTS.

SOLVENTS.
Gesellschaft fuer Biotechnologiache Forschung
m.b.H., Brunswick (Germany, F.R.). Dept. of
Enzyme Technology.
For primary bibliographic entry see Field 5A.
W91-02512

DETERMINATION OF COBALT BY ADSORPTIVE STRIPPING VOLTAMMETRY USING COBALTID-NIOXIME-NITRITE CATALYTIC SYSTEM.

Academy of Mining and Metallurgy, Krakow (Poland). Inst. of Material Science. For primary bibliographic entry see Field 5A.

W91-02513

RELATING SOIL COLOR TO SOIL WATER

TABLE LEVELS.
Ohio State Univ., Columbus. Dept. of Agronomy. For primary bibliographic entry see Field 2G. W91-02539.

ANALYTICAL PROPERTIES OF 4,4'-BIAZO-BENZENEDIAZOAMINOBENZENE AND ITS APPLICATIONS IN SPECTROPHOTOMETRY. China National Environmental Monitoring Beijing. For primary bibliographic entry see Field 5A. W91-02548

DETERMINATION OF TRACE AMOUNTS OF ACETALDEHYDE USING A NOVEL CHEMI-LUMINESCENCE REACTION. University of Science and Technology of China, Hefei. Dept. of Applied Chemistry. X. Lu, M. Lu, and F. Yin. Analytical Letters ANALBP, Vol. 23, No. 7, p 1191-1199, July 1990. 3 fig, 1 tab, 9 ref.

Descriptors: \*Acetaldehyde, \*Chemical analysis, \*Luminescence, \*Pollutant identification, \*Wastewater analysis, \*Water analysis, Analytical techniques, Chemical reactions, Detection times, Kinetics, Selectivity, Trace levels, Water pollu-

Chemiluminescent systems have exhibited considerable advantages for the determination of many metal ions and some inorganic compounds, but determination of organic compounds has received much less attention. The chemiluminescent reaction of isopropyl alcohol with ClO(-)-H2O2 (oxychloride-hydrogen peroxide) was found to been hanced by acetaldehyde. A new chemiluminescent (CL) method for the determination of trace amounts of acetaldehyde was developed. The full chemiluminescent intensity versus time curve, i.e., CL kinetic curve, was recorded. After 4 seconds following the last injection of H2O2 into the reaction cell, the CL intensity reached a maximum and after 8.2 seconds, the CL intensity fell to 50% of the maximum value. Experimental results showed a maximum and constant CL intensity was obtained when the pH of the ClO(-) solution was within 13.2 to 13.6. The detection limit is 0.08 ng/mL acetaldehyde and the linear dynamic range is 0.5 ng/mL to 1000 ng/mL. This method results in good selectivity and has been satisfactorily applied to the determination of traces of acetaldehyde in waste water samples. (VerNooy-PTT)

USING PROGRAMMABLE LOGIC CONTROL

Central Contra Costa County Sanitary District, Martinez, CA. For primary bibliographic entry see Field 5D. W91-02566

REMOTE SENSING APPLICATIONS FOR CONSUMPTIVE USE (EVAPOTRANSPIRA-

Papers Presented at 21st Annual AWRA Confer-ence and Symposium, August 11-16, 1985, Tucson, Arizona. AWRA Monograph Series No. 6, (1985). 72p. Edited by A. I. Johnson and A. Rango.

Descriptors: \*Consumptive use, \*Data acquisition, \*Evapotranspiration, \*Remote sensing, \*Soilwater-plant relationships, Agriculture, Evaporation, Hydrologic cycle, Symposium, Transpiration.

Consumptive use is defined by the American Geo-physical Union as the quantity of water per annum used by either cropped or natural vegetation in transpiration or in the building of plant tissue, together with water evaporated from the adjacent soil, snow or from intercepted precipitation. It is sometimes termed evapotranspiration. In August of 1985, a special session on remote sensing applica-tions for consumptive use was held as part of the 21st Annual Conference of the American Water

Resources Association. This monograph contains a papers that were presented at that session. (SW91-02595 thru W91-02600) (Lantz-PTT) W91-02594

COMBINED SIMULATION OF CANOPY RE-FLECTANCE AND THERMAL RESPONSE FOR ESTIMATING EVAPOTRANSPIRATION. Maryland Univ., College Park. Remote Sensing For primary bibliographic entry see Field 2D. W91-02595

ESTIMATING AREAL EVAPOTRANSPIRA-TION BY COMBINING REMOTE AND GROUND-BASED DATA.

Agricultural Research Service, Phoenix, AZ. Water Conservation Lab. For primary bibliographic entry see Field 2D. W91-02596

ESTIMATES OF CONSUMPTIVE USE AND EVAPOTRANSPIRATION IN PALO VERDE VALLEY, CALIFORNIA, 1981 AND 1983.

Geological Survey, Tucson, AZ. Water Resources For primary bibliographic entry see Field 2D. W91-02597

USING SATELLITE DATA FOR MAPPING AND MONITORING VEGETATION RE-AND MO SOURCES.

For primary bibliographic entry see Field 7C. W91-02599

AGRICULTURAL WATER USE MONITORING THROUGH LANDSAT SURVEILLANCE, Earth Technology Corp., Long Beach, CA. For primary bibliographic entry see Field 3F. W91-02600

INFORMATION COLLECTION REQUEST FOR: NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR INORGANIC CHEMICALS.

Miller (Wade) Associates, Inc., Arlington, VA. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-192413. Price codes: Ad3 in paper copy, Ad0 in microfiche. 6 fig, append. EPA Contract No. 68-03-3348.

Descriptors: \*Data acquisition, \*Drinking water, \*Inorganic compounds, \*National Primary Drinking Water Regulat. \*Regulations, \*Water quality, Asbestos, Barium, Cadmium, Chromium, Copper, Lead, Mercury, Nitrates, Nitrites, Safe Drinking Water Act, Selenium.

Water Act, Seienum.

The EPA, under the requirements of the Safe Drinking Water Act (Section 1401 and 1412, P.L. 99-339, as amended in 1986, has proposed a National Primary Drinking Water Regulation (NPDWR) pertaining to the contamination of public water systems by inorganic chemical contaminants. The proposed inorganic chemical (100C) Rule includes information collection requirements for eight inorganic chemicals: asbestos, barium, cadmium, chromium, mercury, nitrate, nitrite, and selenium. This information collection request analyzes the information burden posed on public water systems and States as a result of the regulation. EPA is proposing only to regulate source-related inorganics under this rule, as opposed to inorganics which predominantly occur as corrosion by-products, and naturally occurring copper and lead are analyzed for lead and corrosion by-products. The EPA has already promulgated a NPDWR for fluoride. (Author's abstract)
W91-026602

VOLUNTEER LAKE MONITORING PROGRAM, 1988, VOLUME VI: SOUTHWESTERN

ILLINOIS REGION.
Southwestern Illinois Metropolitan and Regional Planning Commission, Collinsville.

#### Field 7—RESOURCES DATA

### Group 7B-Data Acquisition

S. E. Andres. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-194740. Price codes: A04 in paper copy, A01 in microfiche. April 1989. 43 p., 28 fig. 20 tab.

Descriptors: \*Hydrologic data collections, \*Illi-nois, \*Lakes, \*Monitoring, \*Public participation, \*Water quality, Aquatic weeds, Coulterville Lake, Data collections, Dunlap Lake, Field tests, Gover-nor Bond Lake, Highland Silver Lake, Holiday Shores Lake, Seasonal variation, Spatial variation, Tower Lake, Transparency, Washington County Lake, Waterloo Reservoir.

This regional report volume is a compilation of lake monitoring data for 11 lakes in the Southwestern Illinois region. Data and analyses are given for those Southwestern Illinois 1988 Volunteer Lake Monitoring Program (VLMP) lakes which were monitored during eight or more sampling periods for the season: Dunlap, Highland Silver, Holiday Shores and Tower Lakes in Madison County; Coulterville Lake in Randolph County; Governor Rond Lake in Bond County. Washington County Coulterville Lake in Randolph County; Governor Bond Lake in Bond County; Washington County Lake in Washington County; and Waterloo Reservoir in Monroe County. For each lake, transparency data and field observations are presented and discussed in terms of spatial and seasonal variations. Aquatic weed growth, management activities, and weather conditions are also discussed. Annual transparency trends and management strategies/recommendations are provided. Additional water quality data for Governor Bond and Tower Lakes are provided. Ambient Lake Monitoring Program data are presented and summarized for Highland Silver Lake. (See also W90-05827) (Lantz-PTT)

INSTALLATION OF A MULTIPORT GROUND-WATER SAMPLING SYSTEM IN

THE 300 AREA.

Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5A.
W91-02670

COMBINING SURFACE GEOELECTRICS AND BOREHOLE MEASUREMENTS FOR CON-TAMINATION CONTROL.

Nebraska Univ., Lincoln. Dept. of Civil Engineer-For primary bibliographic entry see Field 5A. W91-02685

METHOD FOR THE QUANTITATIVE EVAL-UATION OF FISH MOVEMENTS IN SALT PONDS BY ACOUSTIC TELEMETRY.

Centre de Recherche en Ecologie Marine et Aqua culture, Nieul sur Mer (France).

culture, Nieul sur Mer (France).
J. P. Lagardere, J. J. Ducamp, L. Favre, J. M.
Dupin, and M. Sperandio.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 141, No. 2,3, p 221-236, September 18, 1990. 9 fig. 4 tab, 15 ref. Ministere de la Recherche et de la Technologie (84-R-1535 and 973-10.013).

Descriptors: \*Acoustic telemetry, \*Data acquisition, \*Data interpretation, \*Fish behavior, \*Salt marshes, Aquatic habitats, Ponds, Telemetry.

In order to study the activity rhythm and adapta-In order to study the activity rhythm and adaptations of fish in a salt marsh under conditions of extensive culture, it was found necessary to use acoustic telemetry. Due to the effective miniaturization of ultrasonic transmitters, it is possible to fit them to relatively small fish. The pulse signals, which are delivered by the transmitter attached to the fish, are picked up by at least three separate hydrophones. As the relative arrival times of the simulate transmitted by the fish to the three hydrosignals transmitted by the fish to the three hydro-phones (0, 1 and 2) are recorded, two different phones (0, 1 and 2) are recorded, two different propagation times (1 -t0, 12-40) are obtained, which allow the position of the fish tagged with the transmitter to be determined. In fact, on a plane surface, the place where the points corre-spond to a constant difference in time is a hyperbo-la of which the foci are the two receptive hydro-phones. Therefore, the two measured differences in

time correspond to two hyperbolae of which one of the points of intersection determines the position of the transmitter in two dimensions. Because the of the transmitter in two dimensions. Because the area where experimentation took place was not very deep, < 1.5 m, all movements and positions were recorded in two dimensions. This simplification does not result in any major errors as far as the determination of positions is concerned. Experimental evaluation of the constant of error, as allocated per unit area, enabled estimation of the maximal error in the distance travelled and provided accurate comparison of the swipming activities of mai error in the distance travelled and provided accurate comparison of the swimming activities of different specimens. The tracking system can be satisfactorily used to study fish behavior in ponds, with special reference to habitat utilization and levels of swimming activity linked to natural variations in the environment. (Brunone-PTT)

PERIPHYTON ASH WEIGHT ESTIMATION FROM RESIDUE NOT DIGESTED AFTER HACH METHOD OF KJELDAHL PROTEIN NITROGEN ANALYSIS.
Victoria Univ. (British Columbia). Dept. of Biol-

ogy. A. P. Austin, M. J. R. Clark, W. P. Lucey, and C.

A. P. Austin, M. J. R. Chirk, W. F. Leberg, and S. L. Ridley-Thomas.
Water Research WATRAG, Vol. 24, No. 11, p
1323-1324, November 1990. 1 tab, 6 ref. Science
Council of British Columbia Grant No. 90, RC-15
and the National Sci. and Engineering Res. Council of Canada Grant A9537.

Descriptors: \*Analytical techniques, \*Kjeldahl procedure, \*Periphyton, \*Proteins, \*Wastewater analysis, Ash weight, Chemical analysis, Compari-son studies, Hach method, Statistical analysis.

Periphyton ash weight is commonly analyzed as an estimate of entrapped inorganic particulate mass, with the organic component estimated by subtracting the ash weight from the dry weight of the sample. Usually ash weight is determined through ashing of a sample in a muffle furnace. Sometimes, ashing of a sample in a murile rurnace. Sometimes, however, the quantity of biomass available for collection is insufficient to permit analysis by muffle-furnace ashing. The portion of a periphyton sample not digested after acid/peroxide digestion during the Hach method of the Kjeldahl procedure during the Hach method of the Kjeldahl procedure for protein nitrogen determination was examined as an estimator of ash weight. This method, used on periphyton biofilms grown in artificial streams and having ash weights in the 200-300 mg/g range, was found to yield results similar but statistically higher and less precise than the ashing technique traditionally employed for ash weight determination. Student's t comparison of paired analyses by the two methods showed no difference at a significance level of alpha = 0.05, provided a constant of 7.6 mg/g is subtracted from results of the digestion method. It is suggested that the technique may be useful where there would otherwise be insufficient sample for ash weight determination. (White-Reimer-PTT) er-PTT)

NEW LIQUID-JUNCTION FREE PROBE FOR THE IN SITU DETERMINATION OF PH, PH2S AND REDOX VALUES. Kinneret Limnological Lab., Tiberias (Israel). W. Eckert, T. Frevert, and H. G. Truper. Water Research WATRAG, Vol. 24, No. 11, p 1341-1346, November 1990. 5 fig, 1 tab, 25 ref.

Descriptors: \*Hydrogen ion concentration, \*Hydrogen sulfide, \*Measuring instruments, \*Oxidation-reduction potential, \*Water analysis, Comparison studies, Israel, Performance evaluation, Potentiometry, Reference electrodes.

An alternative to the common methods for the in situ determination of pH, pe and pH2S values is presented. The mechanical and electrochemical problems associated with liquid-junction type reference cells for pH and pe measurements can be avoided by using an alkali glass electrode as a reference. The probe was calibrated by comparing it to a precision laboratory pH electrode for a number of lake water samples that were collected at representative depths at the time of the field measurements. Different pe and pH values were

adjusted by saturating the test solution with quin-hydrone and by the addition of 1 N HCl p.a. A regulated temperature and continuous stirring of the tested solution provided constant conditions the tested solution provided constant conditions during the calibration procedure. The short response time of the pH cell (</= 5s) was attributed to the absence of a liquid-junction, to the favorable sodium conditions and to the direct amplification of the measurement signal. The probe displayed EMF readings irrespective of hydrostatical pressure, temperature gradients and the presence of hydrogen sulfide when it was deployed in Lake Kinneret, Israel. (White-Reimer-PTT)

SIMPLE METHOD TO DISTINGUISH BETWEEN POLYPHOSPHATE AND OTHER PHOSPHATE FRACTIONS OF ACTIVATED SLUDGE

Technische Univ., Dresden (German D.R.). Sektion Wasser For primary bibliographic entry see Field 5D. W91-02790

STABILITIES OF CARBOXYLIC ACIDS AND PHENOLS IN LOS ANGELES RAINWATERS DURING STORAGE.

California Univ., Los Angeles. Inst. of Geophysics and Planetary Physics. For primary bibliographic entry see Field 5A.

VELOCITY-DISCHARGE RELATIONSHIPS IN THREE LOWLAND RIVERS.

Sheffield Univ. (England). Dept. of Geography. A. D. Knighton, and R. Cryer. Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 6, p 501-512, September 1990. 5 fig, 3

Descriptors: \*Discharge measurement, \*Flow discharge, \*Flow velocity, \*River flow, \*Routing, \*Stream discharge, \*Stream gaging, Cross-sections, England, Flow models, Hydrologic models.

The use of different functional forms to describe the variation of velocity with discharge was explored for four cross-sections, nine short reaches (100-250 m), and three long reaches (2-7 km) in three lowland rivers in Lincolnshire, England. The traditional log-linear relationship applied to more than half the cases, the degree of correlation never falling below 0.9. Although probably more valid from a physical standpoint, the log-quadratic relationship was only moderately successful, one problem being the position of the vertex relative to bankfull discharge. Alternative formulations based on a kinematic routing model and a partitioned log-linear model were found to have restricted application. Rates of change of velocity with discharge were relatively high in these lowland rivers, not only at-a-station, but also downstream. One explanation is that velocity becomes particularly sensitive to local slope and within-channel vegetation conditions as discharge decreases, resulting in rather low velocities at small discharges. Cross-sectional and reach-based results were compared for neighboring stretches of river. Velocities in short reaches did not differ appreciably from those at nearby cross-sections or from those in long reaches with a length of less than 3 km. By integrating within-reach variability and avoiding the need to choose a representative cross-section, velocity measurement over short reaches is probably The use of different functional forms to describe need to choose a representative cross-section, velocity measurement over short reaches is probably preferable to that at cross-sections as a basis for at-a-station hydraulic geometry. (Author's abstract) W91\_02807

LIQUID WATER CONTENT AND PRECIPITA-TION CHARACTERISTICS OF STRATIFORM CLOUDS AS INFERRED FROM SATELLITE MICROWAVE MEASUREMENTS.

Pennsylvania State Univ., University Park. Dept. of Meteorology.

For primary bibliographic entry see Field 2B. W91-02835

# Evaluation, Processing and Publication—Group 7C

PASSIVE MICROWAVE REMOTE SENSING OF CLOUD LIQUID WATER OVER LAND RE-GIONS.

Cooperative Inst. for Research in the Atmosphere, Fort Collins, CO. For primary bibliographic entry see Field 2B. W91-02836

ESTIMATES OF DAILY RAINFALL OVER THE AMAZON BASIN, Wisconsin Univ.-Madison. Space Science and En-

gineering Center.
For primary bibliographic entry see Field 2B.
W91-02842

CALIBRATION OF TIME DOMAIN REFLECTOMETRY FOR WATER CONTENT MEASUREMENT USING A COMPOSITE DIELEC-TRIC APPROACH.

Eidgenoessische Technische Hochschule, Zurich (Switzerland). For primary bibliographic entry see Field 2G. W91-02857

COMPUTER-CONTROLLED 36-CHANNEL TIME DOMAIN REFLECTOMETRY SYSTEM FOR MONITORING SOIL WATER CON-TENTS.

Amsterdam Univ. (Netherlands). Lab. for Physical Geography and Soil Science. For primary bibliographic entry see Field 2G. W91-02861

INDICATORS OF ECOSYSTEM RECOVERY. Cornell Univ., Ithaca, NY. Ecosystems Research Center

For primary bibliographic entry see Field 5G. W91-02896

COMPUTER-CONTROLLED AUTOMATED RAIN SAMPLER (CCARS) FOR RAINFALL MEASUREMENT AND SEQUENTIAL SAM-PLING.

PLING.
Battelle Pacific Northwest Labs., Richland, WA.
S. D. Tomich, and M. T. Dana.
Journal of Atmospheric and Oceanic Technology
JAOTES, Vol. 7, No. 4, p 541-549, August 1990. 5
fig, 3 tab, 1 ref.

Descriptors: \*Air pollution, \*Automation, \*Chemistry of precipitation, \*Measuring instruments, \*Rain gages, \*Water sampling, Computers, Data acquisition, Meteorologic data, Sensors.

acquisition, Meteorologic data, Sensors.

Sequential sampling of precipitation events, or subevent sampling, is often desirable for obtaining data relating to the processes whereby pollutants are removed from the atmosphere by precipitation. The Computer-Controlled Automated Rain Sampler (CCARS) is a combination of rain gage and sequential sampler for precipitation chemistry measurements. The primary objectives of the design are low cost, versatility of operational mode, and remote siting using battery power. The three major components of the device are the measuring valve (rain gage), sequential distribution valve, and onboard computer that also serves as a controller and data recorder. The measuring valve uses an electromagnetically-operated plunger and optical sensors to divide rain events into adjustable rainfall increments (nominally 0.01 in). The distribution valve, using a stepping motor and a rotating channeled gear, delivers programmed volumes to nine sequential stages. The computer records rain and stage increment timing and can be programmed to sample on a time or volume basis. (Author's abstract)

OBSERVATIONS ON THE DEVELOPMENT OF PORE-WATER STRESSES DURING PIE-ZOCONE PENETRATION IN CLAYS. Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering. P. W. Mayne, F. H. Kulhawy, and J. N. Kay. Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 4, p 418-428, August 1990. 5 fig, 2 tab, 69

ref. Electric Power Research Institute (EPRI) 1990. 2 fig, 9 ref. Contract RP1493-4.

Descriptors: \*Clays, \*Compaction, \*Geologic fractures, \*Instrumentation, \*Interstitial water, \*Penetrometers, \*Piezocone penetration, \*Piezometers, \*Pore water, Mathematical models.

\*Pore water, Mathematical models.

Piezocone data from 83 clay sites were reviewed to investigate first-order trends between measured penetration pore-water stresses (u-t and u-bt) and corrected cone-tip resistance (q-t). The presence of fissures in clay deposits and of fissured crusts significantly affected the pore water stress response. Commercially available piezocones favored the location of the porous element either on the tip or face (u-t) or just behind the tip (u-bt). U-t provided optimal profiling while u-bt was required for correcting measured cone-tip resistances for pore-water stress effects acting on unequal areas of the cone. The available data indicated that q-t pre-dominantly reflected penetration pore-water stresses (u-t) with measured ratios of u-t/q-t on the cone face averaging in the order of 0.73 for most intact clays, 0.64 specifically for Leda clays, and 0.46 for fissured clays. Behind the cone tip, the ratio of u-bt/q-t averaged about 0.53 for intact clays, 0.58 specifically for Leda clays, and near zero or slightly negative for heavily overconsolidated fissured clays. (Author's abstract)

SIMULATION OF DOWNHOLE AND CROSSHOLE SEISMIC TESTS ON SAND USING THE HYDRAULIC GRADIENT SIMILITUDE METHOD.

METHOD. British Columbia Univ., Vancouver. Dept. of Civil Engineering.
L. Yan, and P. M. Byrne.
Canadian Geotechnical Journal CGJOAH, Vol.
27, No. 4, p 441-460, August 1990. 29 fig, 1 tab, 40 ref. 2 appeal. ref, 2 append.

Descriptors: "Anisotropy, "Earthquake engineering, "Mathematical models, "Model studies, "Seismic properties, "Seismic waves, "Seismology, "Soil dynamics, "Soil physics, "Stress, Electrical equipment, Model testing, Piezometers, Sand.

equipment, Model testing, Piezometers, Sand.

A method of simulating downhole and crosshole seismic shear-wave tests in a model under controlled stress conditions is presented. The downhole and shear wave in horizontal plane (SH) crosshole shear waves were generated and received along the principal stress axes using piezoceramic bender elements. The K-(o) in situ stress conditions, including loading and unloading stress paths, were simulated by the hydraulic gradient similitude method, which allow stresses simulating field conditions to be obtained. The horizontal stress during the tests was directly measured by a lateral total-stress transducer. The test data were used to evaluate various published empirical equations that related shear-wave velocity and soil stress state. Although the various empirical equations could predict the in situ shear-wave evlocity profile reasonably well, only the equation that relates the shear-wave velocity to the individual principal stresses in the directions of wave propagation and particle motion could predict the variation of the velocity ratio between the downhole and SH crosshole tests. Also, the stress ratio had some effects on the downhole for shear wave in vertical plane (SV) crosshole) shear-wave velocity. Comparison between the downhole and SH crosshole showed that structure anisotropy was in the order of 10%. In addition, K-o values were predicted from shear-wave measurement and compared with measured ones. The difficulties in oborder of 10%. In addition, K-0 values were pre-dicted from shear-wave measurement and com-pared with measured ones. The difficulties in ob-taining K-(0) values from shear-wave measurement are also presented. (Author's abstract) W91-02939

PROPOSED FRAMEWORK AND DATABASE FOR EIA AUDITING.

Murdoch Univ. (Western Australia). School of Biological and Environmental Sciences.

J. Bailey, and V. Hobbs.

Journal of Environmental Management JEVMAW, Vol. 31, No. 2, p 163-172, September

Descriptors: \*Assessments, \*Auditing, \*Australia, \*Data storage and retrieval, \*Databases, \*Decision making, \*Environmental impact, Canals, Environmental policy, Marinas.

mental policy, Marinas.

Environmental impact assessment (EIA) is intended to provide decision-makers with an understanding of the probable environmental consequences of a proposed project or course of action, and thereby facilitate the making of better environmental decisions. Recently, there has been an upsurge of interest in examining the effectiveness of EIA, and a recognition of the need to introduce feedback into the process to learn from experience. This process is known as auditing, one of the fastest growing areas in the field of EIA. A framework for EIA auditing which focuses on the overall process of EIA rather than the separate analysis of particular stages is presented. The framework was developed through auditing several canal and marina developments in Western Australia and is closely linked to this area's procedures. Data obtained from EIA documentation was used to construct a database of four files which summarize the EIA concepts of proposed actions, imposed environmental conditions, predicted impacts, and observed impacts. The database can be used to undertake an implementation audit, a project impact audit, or a predictive techniques audit, It also allows individual The database can be used to undertake an implementation audit, a project impact audit, or a predictive techniques audit. It also allows individual audits to be evaluated within the wider context of the overall effectiveness of the EIA system. The database has applications at both the academic and practical levels of EIA auditing. (Medina-PTT)

#### 7C. Evaluation, Processing and Publication

ANALYSIS BY FUNCTIONS APPLIED TO HY-DROMETRY (L'ANALYSE PAR FONCTIONS APPLICATION A 'HYDROMETRIE).

Agence Financiere de Bassin Seine-Normandie, Paris (France). F. Guerber.

Houille Blanche HOBLAB, Vol. 1990, No. 5, p 363-374, 1990. 2 fig, 3 tab, 5 ref, 2 append. English

Descriptors: \*Data interpretation, \*Data storage and retrieval, \*Hydrometry, \*Information ex-change, Armancon Basin, France, Mathematical analysis, Network design, Project planning.

Quantified information is becoming more and more necessary for knowing and restoring the natural environment. This information must be gathered during long observation periods, and used by various institutions with various objectives. This is why it is difficult to rationalize the production, storage and diffusion of environmental information. Analysis by function is one method which contributes to this effort of rationalization, by defining the concepts of fields and functions. This method is described, and illustrated with a case using hydrometric data. The method results in some quantification, which may help measurement networks and data banks to become better able to satisfy the needs of their users. Applied to the concrete case of the Armancon basin, the method helps to justify, both technically and financially, project plans to develop a hydrometric measure network. (Author's abstract) Quantified information is becoming more and more

RATIOS IN AQUATIC SCIENCES: STATISTI-CAL SHORTCOMINGS WITH MEAN DEPTH AND THE MORPHOEDAPHIC INDEX.

D. A. Jackson, H. H. Harvey, and K. M. Somers.

Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 9, p 1788-1795, September 1990. 5 fig, 1 tab, 40 ref.

Descriptors: \*Lake morphometry, \*Model studies, \*Morphoedaphic index, \*Statistical analysis, Abundance, Biomass, Fish populations, Productivity,

#### Field 7—RESOURCES DATA

## Group 7C-Evaluation, Processing and Publication

Researchers in aquatic sciences frequently employ empirically derived models to predict productivity, yield and abundance of fish. Three normally disyield and abundance of fish. Three normally distributed variables, each with a mean of 100 and standard deviation of 30, were generated, and common ratios (biomass versus total lake area, BPUA ws. lake mean depth, BPUA vs. the inverse of mean depth, and log BPUA vs. log mean depth) were calculated. Pearson product-moment correlations and Spearman rank correlations were used to assess the strength of the associations between variables. To determine the probability of rejecting the null hypothesis for each of these correlations, randomization tests were used. Ten data sets were selected from the literature for ratio generation and comparison with the simulations. Predictive selected from the interature for ratio generation and comparison with the simulations. Predictive models employing ratios of standardized biomass and lake morphometric variables are biased by spurious correlations due to mathematical transformations and the use of inappropriate null models. Studies incorporating ratios like mean depth or the morphoedaphic index require cautious interpreta-tion. Future research should focus on more approuon. ruture research snoute rocus on more appro-priate analytical approaches such as regression-based models (the analysis of covariance). Alterna-tively, where ratios are employed and spurious correlations are likely, statistical evaluations must incorporate randomization tests to assess the significance of such results. (Brunone-PTT)

SOLUTE TRANSPORT THROUGH SATURAT-ED SOILS: A STUDY OF THE PHYSICAL NON-EQUILIBRIUM MODEL.
Claremont Graduate School, CA. Dept. of Mathe-

matics. For primary bibliographic entry see Field 5B. W91-02090

MODELLING PHYTOPLANKTON PRODUCTIVITY IN TURBID WATERS WITH SMALL EUPHOTIC TO MIXING DEPTH RATIOS. Orange Free State Univ., Bloemfontein (South Africa). Dept. of Botany. For primary bibliographic entry see Field 2H. W91-02115

RANGE PROFILING OF THE RAIN RATE BY

NATION PROFILING OF THE RAIN RATE BY AN AIRBORNE WEATHER RADAR. National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 2B. W91-02128

SIMPLIFIED METHOD TO ESTIMATE RE-GIONAL 24-H EVAPOTRANSPIRATION FROM THERMAL INFRARED DATA.

Winand Staring Centre for Integrated Land, Soil and Water Research, Wageningen (Netherlands). For primary bibliographic entry see Field 2D. W91-02129

MODELLING ENVIRONMENTAL SCENARIOS IN PONDS.

BARTON IN PONIS.

Bayreuth Univ. (Germany, F.R.). Chair of Ecological Chemistry and Geochemistry.

K. W. Shramm, and K. U. Goss.

Toxicological and Environmental Chemistry

TXECBP, Vol. 26, No. 1/4, p 123-128, 1990. 5 fig.

Descriptors: \*Biodegradation, \*Computer models, \*Fate of pollutants, \*MESIP model, \*Model studies, \*Organic chemicals, \*Path of pollutants, \*Ponds, Advection, Chemical processes, Diffusion, Dissolved oxygen, Solute transport.

MESIP is a fugacity model which can predict the fate of organic chemicals in aquatic ecosystems. Aquatic ecosystems are divided into air, water, Aquatic ecosystems are divided into air, water, suspended matter, 4 sediment layers, and biological growth on the pond walls. All compartments are considered to be well-mixed. Two types of transport phenomena are considered Mass exchange between compartments is assumed to be a diffusion type process. The transport kinetics across the interphases are dependent upon the corresponding

transfer coefficients and the fugacity differences represent the driving forces between the compart-ments. Advection is assumed to be responsible for import and export of substances into and out of each compartment. Degradation/transformation processes are important aspects of the model. Pho-tolytic, hydrolytic, biological, and oxidation/re-duction processes are assumed to be a pseudo first-order kinetic. The constants are corrected by additional time dependent parameters which characterize the different conditions in each compartment, including light intensity, pH, ATP/DOC, and oxygen concentration. Comparison of the calculated and measured fate of a fluorescent whitening compound in an artificial outdoor pond indicated an underestimation of transport due to the pres-ence of a biological film on the top sediment layer. (Tappert-PTT) W91-02176

NEW METHOD TO DETERMINE REGIONAL EVAPOTRANSPIRATION.

Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.

For primary bibliographic entry see Field 2D. W91-02184

APPROXIMATION OF CONFIDENCE LIMITS ON SAMPLE SEMIVARIOGRAMS SINGLE REALIZATIONS OF SPA CORRELATED RANDOM FIELDS.

Illinois State Water Survey Div., Champaign. Ground-Water Section.

J. M. Shafer, and M. D. Varljen.

Water Resources Research WRERAQ, Vol. 26, No. 8, p 1787-1802, August 1990. 21 fig, 1 tab, 39

Descriptors: \*Confidence limits, \*Correlation analysis, \*Environmental data, \*Geostatistics, \*Network design, \*Statistical analysis, \*Statistical methods, Spatial distribution, Uncertainty.

A fundamental requirement for geostatistical analyes of spatially correlated environmental data is the estimation of the sample semivariogram to characterize spatial correlation. Selecting an underlying theoretical semivariogram based upon the semivariogram is an extremely important and difficult task that is subject to a great deal of uncertainty. Current standard practice does not involve consideration of the confidence associated myove consideration of the confidence associated with semivariogram estimates, largely because classical statistical theory does not provide the capability to construct confidence limits from single realizations of correlated data, and multiple realizations of environmental fields are not found in nature. The jackknife method is a nonparametric in nature. The jackstime memor is a nonparameter statistical technique for parameter estimation that may be used to estimate the semivariogram. When used in connection with standard confidence procedures, it allows for the calculation of closely approximate confidence limits on the semivario-gram from single realizations of spatially correlat-ed data. The accuracy and validity of this tech-nique was verified using a Monte Carlo simulation approach which enabled confidence limits about the semivariogram estimate to be calculated from many synthetically generated realizations of a random field with a known correlation structure. The synthetically derived confidence limits were The synthetically derived confidence limits were then compared to jackknife estimates from single realizations with favorable results. Finally, the methodology for applying the jackknife method to a real-world problem and an example of the utility of semivariogram confidence limits were demonstrated by constructing confidence limits on seasonal sample variograms of nitrate-nitrogen concentrations in shallow groundwater in an approximately 12 square mile region in northern Illinois. In this application, the confidence limits on sample semivariograms from different time periods were in this application, the connidence limits on sample semivariograms from different time periods were used to evaluate the significance of temporal change in spatial correlation. This capability is quite important as it can indicate when a spatially optimized monitoring network would need to reevaluated and this lead to more robust monitoring strategies. (Author's abstract) W91-02187

CURIOUS BEHAVIOR OF A GROUNDWATER FLOW MODEL

Butler Univ., Indianapolis, IN. Dept. of Mathematical Sciences For primary bibliographic entry see Field 2F.

GEOCHEMISTRY OF BATCH-EXTRACT WATERS DERIVED FROM SPOIL MATERIAL COLLECTED AT THE CORDERO COAL MINE, POWDER RIVER BASIN, WYOMING. Geological Survey, Cheyenne, WY. Water Resources Div.

For primary bibliographic entry see Field 5B. W91-02222

ANALYSIS OF WATER SURFACE AND FLOW DISTRIBUTION FOR THE DESIGN FLOOD AT A PROPOSED HIGHWAY CROSSING OF THE SABINE RIVER NEAR TATUM, TEXAS. Geological Survey, Austin, TX. Water Resources Div.

For primary bibliographic entry see Field 2E. W91-02226

FRESHWATER WITHDRAWALS IN TEXAS,

Geological Survey, Austin, TX. Water Resources

D. L. Lurry, and N. L. Barber. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4044, 1990. 1 sheet, 1 tab, 9 ref.

Descriptors: \*Groundwater resources, \*Selective withdrawal, \*Texas, \*Water resources data, \*Water use, Maps, Surface water.

Freshwater withdrawal data was compiled for the 254 counties in Texas for 1985. Major categories of withdrawal are presented by county on maps of the State. Withdrawals are also shown by source, aquifer, and major river basin. Total freshwater withdrawals in Texas during 1985 were about 20,100 million gal/day. Surface-water withdrawals were about 12,900 million gal/day or 64% of the total, and groundwater withdrawals were about 7,190 million gal/day or 36% of the total. More water was withdrawn for irrigation than for any other purpose, accounting for 40% of total freshwater withdrawals and for 75% of groundwater withdrawals. (USGS) withdrawals. (USGS) W91-02228

MASS-CONSERVING METHOD OF CHARAC-TERISTICS FOR STREAMFLOW MODELING. Geological Survey, Tacoma, WA. Water Resources Div.

For primary bibliographic entry see Field 2E. W91-02234

U. S. GEOLOGICAL SURVEY APPLIED RE-SEARCH STUDIES OF THE CHEYENNE RIVER SYSTEM, SOUTH DAKOTA: DESCRIP-TION AND COLLATION OF DATA, WATER YEARS 1987-88.

Geological Survey, Rapid City, SD. Water Resources Div.

For primary bibliographic entry see Field 5B. W91-02235

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN KANSAS-FISCAL YEARS 1987 AND 1988.

Geological Survey, Lawrence, KS. Water Resources Div. L. J. Combs.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-592, 1989. 96p, 11 fig, 6 tab,

Descriptors: \*Data acquisition, \*Data collections, \*Groundwater data, \*Hydrologic data collections,

# Evaluation, Processing and Publication—Group 7C

\*Kansas, \*Water resources data, Information exchange, Surface water data, Water quality data.

The principal mission of the U.S. Geological Survey, Water Resources Division, in Kansas is to investigate the occurrence, quantity, quality, distri-bution, and movement of surface and groundwater investigate the occurrence, quantity, dustri-bution, and movement of surface and groundwater throughout the State. Primary activities include the systematic collection, analysis, and interpreta-tion of hydrologic data, evaluation of water de-mands, and water resources research. Hydrologic investigations are conducted through four types of studies: (1) data collection programs; (2) statewide or regional investigations; (3) local or area investi-gations; and (4) research. These studies are funded through cooperative agreements with State and local agencies, transfer of funds from other agen-cies, and direct Federal funds. Thirty-six water related studies were ongoing during fiscal years 1987 and 1988 in Kansas. This report describes for each study the problem that initiated the study, the objectives of the study, the approach designed to achieve the objectives, and significant milestones and publications that resulted during fiscal years 1987 and 1988. Information on more than 2,100 data collection stations in Kansas is presented in maps and tables. A list of 46 reports and abstracts uata collection stations in Kansas is presented in maps and tables. A list of 46 reports and abstracts published or released by the U.S. Geological Survey, its cooperators, or technical and scientific organizations during 1987 and 1988 is provided. (USGS)

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1989, VOLUME 3B: SOUTH-WEST FLORIDA GROUND WATER.

Geological Survey, Tampa, FL. Water Resources Div.

Div. Available from National Technical Information Service, Springfield, VA 22161 as PB90-244773. Price codes: A15 in paper copy; A02 in microfiche. USGS Water Data Report FL-89-3B. USGS/WRD/HD-90/267, 1990, 327p. Prepared in cooperation with the State of Florida and other agen-

Descriptors: \*Florida, \*Groundwater, \*Hydrologic data, \*Surface water, \*Water quality, Chemical analysis, Data collections, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments. Water analysis, Water level, Water temperature, Water wells

Water resources data for the 1989 water year for Water resources data for the 1989 water year for 19orida consist of continuous or daily discharge for 295 streams, periodic discharge for 36 streams, miscellaneous discharge for 75 streams, continuous or daily stage for 154 streams, continuous daily tide stage for 12 sites, periodic stage for 13 streams, peak discharge for 57 streams, and peak stage for 30 streams; continuous or daily elevations for 73 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 514 wells, periodic groundwater levels for 514 wells, and miscellaneous water levels for 78 wells and miscellaneous water. water levels for 798 wells and miscellaneous water level measurements for 2687 wells, quality of water level measurements for 2687 wells, quality of water data for 149 surface-water sites and 827 wells. The data for southwest Florida include records of data for southwest rioriou include records of stage, discharge, and water quality of streams; stage, contents, water quality of lakes and reser-voirs, and water levels and water quality of groundwater wells. Volume 3B contains records for continuous groundwater elevations for 200 wells; periodic groundwater elevations at 126 weis; periodic groundwater elevations at 126 wells; miscellaneous groundwater elevations at 147 wells; and water quality at 167 groundwater sites. These data represent the national Water Data System records collected by the U.S. Geological Survey and cooperating local, state, and federal agencies in Florida. (USGS) W91-02240

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1989. Geological Survey, Salt Lake City, UT. Water

Resources Div.

Available from National Technical Information
Service, Springfield, VA 22161 as PB90-239849/
AS. Price codes: A17 in paper copy; A03 in microfiche. USGS Water Data Report UT-89-1. USGS/
WRD/HD-90/272, 1990, 383p. Prepared in cooperation with the State of Utah and with other

agencies

Descriptors: \*Groundwater, \*Hydrologic data, \*Surface water, \*Utah, \*Water quality, Chemical analysis, Data collections, Flow rates, Gaging sta-tions, Lakes, Reservoirs, Sampling sites, Sedi-ments, Water analysis, Water level, Water temper-ature, Water wells.

Water resources data for the 1989 water year for Utah consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water quality of groundwater. This report contains discharge records for 185 gaging stations; stage and contents for 22 lakes and reservoirs; water quality for 21 hydrologic stations and 217 wells; miscellaneous temperature measurements and field determinations for 147 stations; and water levels for 29 observation wells. tions; and water levels for 29 observation wells. tions; and water levels for 29 observation wells. Additional water data were collected at various sites not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent the national Water Data System records collected by the U.S. Geological Survey and cooperating State and Federal agencies in Utah. (USGS) W91-02241

PREPARATION OF AVERAGE ANNUAL RUNOFF MAP OF THE UNITED STATES.

Geological Survey, Madison, WI. Water Resources Div.

W. R. Krug, W. A. Gebert, and D. J. Graczyk. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 87-535, 1990. 414p, 2 tab, 8 ref.

Descriptors: \*Data collections, \*Hydrologic data, \*Maps, \*Runoff, \*Stream discharge, Correlation analysis, Gaging stations.

Average annual runoff was computed or estimated for 2,148 hydrologic cataloging units in the United States and Puerto Rico, for the period 1951-80. Runoff was computed from the recorded stream-flow at 5,951 U.S. Geological Survey gaging sta-tions. The runoff at more than 3,000 of these stations was estimated by correlation with other nearby stations to adjust for missing data. These runoff data were used to draw a map depicting the variation of runoff throughout the nation. Average annual runoff varied from less than 0.01 inch in parts of the Great Basin (Utah, parts of Nevada, Oregon, and California) to more than 240 inches in southeastern Alaska. (USGS) W91-02247

GROUND-WATER LEVELS IN ARKANSAS, **SPRING 1990.** 

Geological Survey, Little Rock, AR. Water Resources Div. P. W. Westerfield.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-377, 1990. 62p, 5 fig, 16 tab, 42 ref.

Descriptors: \*Arkansas, \*Data collections, \*Groundwater level, \*Hydrologic data, Aquifers, Well hydrographs.

Groundwater level measurements were made in 553 wells in Arkansas in the spring of 1990. These data are listed in tables by aquifer; then by county. For each surface, the altitude of the land surface, the data measured, the depth to the water surface, and the altitude of the water surface are reported. and the altitude of the water surface are reported. Also reported are the net changes in water levels between 1989 and 1990 and between 1985 and 1990. This report also contains maps showing the average water level change, by county, between the years 1985 and 1990 for the aquifers in the Quaternary deposits and the Sparta and Memphis Sands. Hydrographs are included for selected wells completed in the aquifers in the Quaternary deposits and the Sparta and Memphis Sands. (USGS) W91-02250

FATHOMETER DATA FROM BART LAKE AND LAKE DOROTHY NEAR JUNEAU, ALASKA, 1988-89.

Geological Survey, Anchorage, AK. Water Resources Div.

H. R. Seitz, and D. S. Thomas.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-152, 1990. 14p, 11 fig, 5 ref.

Descriptors: \*Alaska, \*Bathymetry, \*Hydroelectric power, \*Lakes, \*Water resources data, Fathometers, Juneau, Water depth.

Lake Dorothy is located about 20 miles southeast of Juneau, Alaska in an undeveloped area south of Taku Inlet. It occupies a linear, glacially eroded depression at an altitude of 2,400 ft. Several studies have assessed the feasibility of hydropower genera-tion by a tap of Lake Dorothy. One of the proposed alignments, a tunnel to transmit water from lake Dorothy to a powerhouse at tide water on Taku Inlet, crosses Bart Lake, a cirque lake at 986 ft altitude. Fathometer surveys show that Bart Lake is a relatively symmetrical bowl-shaped depression with a maximum depth of 543 ft, and Lake Dorothy is a north-south elongated depression with steep sides and a maximum depth of 569 ft. (USGS) W91-02254

DIFFERENCE BETWEEN THE POTENTIOME-TRIC SURFACE OF THE AQUIA AQUIFER OF SEPTEMBER 1986 AND SEPTEMBER 1988 IN SOUTHERN MARYLAND.

Geological Survey, Towson, MD. Water Resources Div.
F. K. Mack, D. C. Andreasen, S. E. Curtin, and J.

Wheeler

C. Wheeler. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4039, 1990. 1p, 1 fig.

Descriptors: \*Aquia Aquifer, \*Artesian aquifers, \*Coastal plains, \*Maps, \*Maryland, \*Potentiometric level, Anne Arundel County, Calvert County, Charles County, Groundwater level, Prince Georges County, St Marys County.

A map was prepared that shows the net change in the potentiometric surface of the Aquis aquifer (in the Paleocene Aquia Formation) in southern Maryland from the fall of 1986 to the fall of 1988. The map, based on water level measurements from 74 observation wells, shows that during the 2 year period the potentiometric surface declined less than 6 ft in most of southern Maryland but 10 ft or more in the Lexington Park and Solomons Island W91-02255

DIFFERENCE BETWEEN THE POTENTIOME-TRIC SURFACE OF THE MAGOTHY AQUI-FER OF SEPTEMBER 1986 AND SEPTEMBER 1988 IN SOUTHERN MARYLAND. Geological Survey, Towson, MD. Water Re-

sources Div F. K. Mack, D. C. Andreasen, S. E. Curtin, and J.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4038, 1990. 1p, 1 fig.

Descriptors: \*Artesian aquifers, \*Coastal plains, \*Magothy Aquifer, \*Maps, \*Maryland, \*Potentiometric level, Anne Arundel County, Calvert County, Charles County, Groundwater level, Maryland Coastal Plain, Prince Georges County.

A map was prepared that shows the net change in the potentiometric surface of the Magothy aquifer (in the Cretaceous Magothy Formation) in south-ern Maryland from the fall of 1986 to the fall of 1988. The map, based on water level measurements from 79 observation wells, shows that during the 2 year period the potentiometric surface declined less than 5 ft in most of the northern part of the study area and more than 10 ft in a 4-sq-mi area in

## Group 7C—Evaluation, Processing and Publication

northern Charles County. Net water-level rises of as much as 2 ft were measured in central Charles County. (USGS) W91-02256

POTENTIOMETRIC SURFACE OF THE AQUIA AQUIFER IN SOUTHERN MARY-LAND DURING SEPTEMBER 1988, Geological Survey, Towson, MD. Water Re-

sources Div. F. K. Mack, D. C. Andreasen, S. E. Curtin, and J.

C. Wheeler. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225, USGS Water-Resources Investigations Report 90-4037, 1990. lp, 1 fig.

Descriptors: \*Aquia Aquifer, \*Artesian aquifers, \*Coastal plains, \*Maps, \*Maryland, \*Potentiometric level, Anne Arundel County, Calvert County, Charles County, Groundwater level, Maryland Coastal Plain, Prince Georges County.

A map showing the potentiometric surface of the Aquia aquifer in the Paleocene Aquia Formation in southern Maryland during the fall of 1988 was constructed on the basis of water level measure-ments made at 84 observation wells. The potentioments made at 84 observation wells. The potentio-metric surface was above sea level near the north-western boundary and outcrop area of the aquifer in topographically high areas of Anne Arundel and Prince Georges Counties; it was below sea level in the remainder of the study area. The hydraulic gradient generally was to the southeast toward an extensive cone of depression centered around well fields near Lexington Park and Solomons Island. Water levels were more than 60 ft below sea level water levels were more than 60 It below sea level in a 50 sq-mi area near the center of the cone and were more than 100 ft below sea level at two of the wells near the center of the cone. (USGS) W91-022S7

WATER RESOURCES ACTIVITIES IN FLORI-

DA, 1989-90. Geological Survey, Tallahassee, FL. Water Re-

Geologica: Survey, Sand Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-169, 1990. 92p, 6 fig. Edited

Descriptors: \*Projects, \*Publications, Data collections, Handbooks, Hydrologic data.

This report contains 62 summary statements of water resources activities in Florida conducted by the Water Resources Division of the U.S. Geological Survey in cooperation with Federal, State, and local agencies during 1989-90. These activities are part of the Federal program of appraising the Nation's water resources. (USGS) W91-02258

ACTIVITIES OF THE ALASKA DISTRICT, WATER RESOURCES DIVISION, U. S. GEO-LOGICAL SURVEY, 1990.

Geological Survey, Anchorage, AK. Water Re-

Geological Survey, Alchorage, A.R. Water Resources Div. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-157, 1990. 21p. E. F. Snyder,

Descriptors: \*Alaska, \*Data collections, \*Hydrologic data, \*Water resources data, Bibliographies, Groundwater, Hydrology, Project planning, Surface water, Water quality.

Thirteen projects of the U.S. Geological Survey, Water Resource Division active in Alaska in 1990 water Resource Division active in Anaska in 1990 are described. Each description includes information on period of project, chief, funding sources, location, purpose, current status, and published or planned reports. The compilation also contains a bibliography of reports published by the Alaska District from 1987 through January 1990. (USGS)

WATER RESOURCES DATA FOR ARKANSAS, WATER YEAR 1989.

Geological Survey, Little Rock, AR. Water Re-

sources Div. M. A. Moore, J. E. Porter, P. W. Westerfield, and

K. Young.

Available from the National Technical Information Available from the National I echnical Information Service, Springfield, VA 2161 as PB90-266339. Price codes: A25 in paper copy, A04 in microfiche. USGS Water-Data Report WDR-AR-89-1. WRD/HD-90/261, 1990. 581p. Prepared in cooperation with the State of Arkansas and with other agencies.

Descriptors: \*Arkansas, \*Data collections, \*Groundwater, \*Hydrologic data, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Sampling sites, Sedimens, Water analysis, Water level, Water temperature.

The Water Resources Division of the U.S. Geological Survey, in cooperation with State, Federal, and other local governmental agencies, obtains a large amount of data pertaining to the water resources of Arkansas each water year. These data, accumulated during many water years, constitute a valuable data base for developing an improved understanding of the water resources of the State. Water resources data for the 1989 water year for Arkansas consist of records of gage height, discharge, and water quality of streams; water quality of lakes; water levels, and water quality of observation wells. This report contains discharge records for 54 gaging stations; water-quality data for 160 regular water-quality stations, 65 partial-record water-quality stations, 40 servation wells, and 1 precipitation station; water-level measurements for 89 observation wells. Also included are data for 81 crest-stage partial-record surface-water data for 81 crest-stage partial-record surface-water data for 81 crest-stage partial-record surface-water stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as low-flow and miscellaneous measurements. These data represent that part of the National Water Information System operated by the U.S. Geological Survey in cooperation with State and Federal agencies in Arkansas. (See also W90-06282) (USGS)

HYDROLOGICAL MODELLING FOR WATER MANAGEMENT IN ARID AND SEMI-ARID AREAS OF AFRICA.

Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2A.

CIEH'S CONTRIBUTION TO THE DEVELOP-MENT OF HYDROLOGY IN ARID AND SEMI-ARID AREAS IN AFRICA (CONTRIBUTION DU CIEH AU DEVELOPPEMENT DE L'HY-DROLOGIE DANS LES ZONES ARIDES ET SEMI-ARIDES D'AFRIQUE).

Comite Interafricain d'Etudes Hydrauliques, Oua-gadougou (Burkina Faso). Dept. of Hydrology. For primary bibliographic entry see Field 2A.

W91-02292

FRACTAL APPROACH TO SPATIAL VARIA-BILITY OF WEST AFRICAN RAINFALL EVENTS (APPROCHE FRACTALE DE LA VARIABILITE SPATIALE DES EPISODES PLUVIEUX DE L'AFRIQUE DE L'OUEST). Ecole Nationale Superieure des Mines de Paris (France). For primary bibliographic entry see Field 2B.

W91-02301

ANALYSIS OF NON-STATIONARITY OF WEST AFRICAN RAINFALL AND HYDROLO-GICAL SERIES (ANALYSE DE LA NON STA-TIONNARITE DES SERIES PLUVIOMETRI-QUES ET HYDROLOGIQUES D'AFRIQUE DE LOUISES L'OUEST). Paris-6 Univ. (France). Dept. de Geologie Dyna-

For primary bibliographic entry see Field 2B. W91-02302

PROBLEM OF WATER BALANCE MODEL-LING UNDER SEMI-ARID CONDITIONS.

Oslo Univ. (Norway). Inst. of Geophysics. E. Langsholt, and L. Gottschalk.

E. Langsholl, and L. Gottschalk.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 242-254, 6 fig. 1 tab, 11 ref.

Descriptors: \*Botswana, \*Hydrologic budget, \*Hydrologic models, \*Model studies, \*Semiarid lands, Comparison studies, Mahalapswe catchment, Mathematical models, Rainfall-runoff relationships, Spatial variation, Temporal variation.

Analyses were conducted of hydrological data from the Mahalapswe catchment in Botswana in an atom the how conceptual models developed mainly under humid conditions perform in semi-arid climates and how the characteristics of precipitation influence modeling accuracy. Meteorological and hydrological variables in semi-arid logical and hydrological variables in semi-arid areas are characterized by extreme temporal and spatial variability, but quantitative knowledge about this variability is rather poor. The accuracy in estimated areal precipitation was determined from the distance correlation of rain events, showing the relation between absolute mean square error and the density of the observation station network. The analysis was carried out for time periods of different length. A model study was conducted using precipitation and runoff data from the same catchment to study the effect of the above factors on model calculations of runoff. Sevabove factors on model calculations of runoff. Sev-eral conceptual water balance models with different degrees of complexity in model structure and spatial averaging of precipitation were used. The results seem to support the principle that when information available is not limited with respect to quantity and quality it may not pay to try to describe the true complexities present in a given situation. (See also W91-02288) (Author's abstract)

SOME EXAMPLES OF IMPORTANT PROB-LEMS CONNECTED TO RAINFALL-RUNOFF MODELLING IN SEMI-ARID ZONE.

Lund Univ. (Sweden). Dept. of Water Resources

Lund Univ. (Sweden). Dept. of Water Resources Engineering.

J. Niemczynowicz.

IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 255-266, 4 fig. 14 ref.

Descriptors: \*Hydrologic models, \*Model studies, \*Rainfall-runoff relationships, \*Semiarid lands, \*Tunisia, Climates, Evaporation, Mathematical models, Rural areas, Soils, Topography, Urban

Several hydrological research projects have been conducted in Tunisia in cooperation between the Ministry of Higher Education in Tunis, Tunisia, and the University of Lund, Sweden. Mathematical modeling of rainfall-runoff processes on both urban and rural catchemets was an important part cal modeling or rannal-runori processes on our urban and rural catchments was an important part of these projects. Problems that occurred forced the questioning of assumptions and mathematical formulations behind rainfall-runoff models origiformulations behind rainfall-runoff models origi-nally developed for application in a humid climate. A second question confronted was how to modify and adapt these models to climatological, geologi-cal, topographical, and hydrological conditions specific for the semi-arid zone. One conclusion drawn from trying to apply these models to the semi-arid climate of Tunis was that an obvious improvement in the applicability of the model to semi-arid regions can be achieved by refining the mathematical formulation of the processes that are most important to the region. Existence of differmost important to the region. Existence of differ-ences in soil type, topography, and rainfall pattern suggest that such processes as infiltration, soil moisture storage, rainfall spatial distribution, evaporation, and groundwater recharge must be studied carefully to find governing relationships and thus enable improvement of the mathematical formulation of these processes. (See also W91-02288) (AuW91-02308

UTILIZATION OF THE LAW OF GAPS FOR THE DESCRIPTION OF THE PLUVIOMETRIC REGIME (L'UTILISATION DE LA LOI DES FUTTES POUR LA DESCRIPTION DES REGIMES PLUVIOMETRIQUES). Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Niamey (Niger). Mission ORSTOM au Niger. For primary bibliographic entry see Field 2B. W91-02345

GLOBAL MODELLING OF THE RAIN-RUNOFF RELATIONSHIP: A TOOL FOR EVALUATION OF WATER RESOURCES (MO-DELISATION GLOBALE DE LA RELATION PLUIE DEBIT: DES OUTILS AU SERVICE DE L'EVALUATION DES RESSOURCES EN EAU, Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Abidjan (Ivory Coast). Centre ORSTOM d'Adiopodoume. For primary bibliographic entry see Field 2E. W91-02349

USE OF PERSONAL COMPUTERS FOR THE ANALYSIS AND MANAGEMENT OF HYDRO-METEOROLOGICAL AND GROUNDWATER DATA.

DATA.
Institute of Hydrology, Wallingford (England).
F. A. K. Farquharson, and C. S. Green.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 772-782, 4 fig, 1 ref.

Descriptors: \*Africa, \*Computer programs, \*Data processing, \*Groundwater data, \*Hydrologic data, \*Microcomputers, \*Water resources management, Arid lands, GRIPS, HYDATA, Hydrometeorology, Performance evaluation, Semiarid lands.

Much of Africa has an arid or semi-arid clim and experiences wide variations in annual rainfall and river discharges. Much of the current ground-water abstraction is of fossil water, which is not being renewed by recharge. Better management of the fragile water resources within this region re-quires very careful provincing and analysis of the the fragile water resources within this region requires very careful monitoring and analysis of the hydrometeorological and hydrological data. Modern personal computers (PCs) are relatively cheap but are surprisingly reliable and offer considerable data storage and computing power. Two software systems were developed for analysis of water resources data on PCs. HVDATA is designed for storage and analysis of data on rainfall, climate, river level and flow, reservoir storage and general information, such as evaporation and temperature. GRIPS (GRoundwater Information Processing System) is for storage and analysis of all types of data encountered in hydrogeological studies (station locations, water levels, lithology, pumping tests, water chemistry, isotopes, etc.). studies (station locations, water levels, intiology, pumping tests, water chemistry, isotopes, etc.). The software was developed by hydrologists and hydrogeologists who have years of first-hand, practical experience working in Africa. The softpractical experience working in Africa. The soft-ware is designed to be robust, error free, and easy to use by the unskilled and poorly trained staff who may never have seen or used a computer before. The two software systems have been fully tested and HYDATA has been used in 16 coun-tries, whereas the GRIPS has been used in six countries. (See also W91-02288) (Author's abstract) W91-02351

ARRIVAL OF A GENERATION OF FIELD EXPERT SYSTEMS (L'AVENEMENT D'UNE GENERATION DE SYSTEMES EXPERTES DE TERRAIN).

TERRAIN).
ILOG S.A., Gentilly (France).
P. Poyet, and M. Detay.
IN: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Il-

linois. 1990. p 800-811, 39 ref. English summary.

Descriptors: \*Africa, \*Cameroon, \*Computers, \*Developing countries, \*Expert systems, \*Sampling, \*Water supply development, \*Wells, Drilling, Field tests, HYDROLAB, Rural areas, Sur-

A first field expert system for village water supply A first field expert system for village water supply has been developed to operate on portable personal computers. HYDROLAB embodies the major techniques used by experts in the field and draws on a considerable wealth of practical knowledge gained from numerous drilling campaigns that were carried out in Africa, particularly in North Cameroon. For any case, the system can make a diagnosis about the user's situation, give advice in order to increase his average success, estimate the drilling risk, and evaluate the hydrodynamic characteristics of the proposed well. (See also W91-02288) (Author's abstract)

INTEGRATED APPROACH FOR THE EVAL-INTEGRATED APPROACH FOR THE EVALUATION OF GROUNDWATER RESOURCES: A CASE STUDY IN YATENGA (APPROCHE INTEGREE POUR L'EVALUATION DES RESSOURCES EN EAU SOUTERRAINES: ETUDE DE CAS AU YATENGA).

Ministry of Water Resources, Ouagadougou (Burling Early).

For primary bibliographic entry see Field 2F. W91-02356

ESTIMATES OF EVAPOTRANSPIRATION WITH A ONE- AND TWO-LAYER MODEL OF HEAT TRANSFER OVER PARTIAL CANOPY

Agricultural Research Service, Beltsville, MD. Hydrology Lab. For primary bibliographic entry see Field 2D. W91-02408

PHYSICAL, CHEMICAL AND HYDROGRAPHIC INVESTIGATIONS OF AN UPLAND STREAM: A CONTRIBUTION ON THE STANDARDIZATION OF SMALL WATER-COURSES (PHYSIKALISCHE, CHEMISCHE UND HYDROGRAPHISCHE UNTERSUCHUNGEN EINESC MITTELGEBIRGSBACHES: EIN BEITRAG ZUR TYPISIERUNG KLEINER FLIESSGEWASSER).

Konstanz Univ. (Germany, F.R.). Limnological

For primary bibliographic entry see Field 2E. W91-02449

ESTIMATING THE FORESTED-WETLAND RESOURCE IN THE SOUTHEASTERN UNITED STATES WITH FOREST SURVY DATA.

Southeastern Forest Experiment Station, Asheville, NC.

For primary bibliographic entry see Field 4C. W91-02484

WATERSHED DELINEATION WITH TRIAN-

GLE-BASED TERRAIN MODELS, Texas Univ. at Austin. Dept. of Civil Engineering. For primary bibliographic entry see Field 2E. W91-02525

COONGIE LAKES CONTROL ZONE—A MAP AND NOTE FOR THE SURFACE GEOLOGY AND TERRAIN. For primary bibliographic entry see Field 2H. W91-02531

SUPERCOMPUTERS AND THEIR USE IN MODELING SUBSURFACE SOLUTE TRANS-

Western Australia Univ., Nedlands. Centre for Water Research.

Water Research D. A. Barry. Reviews of Geophysics RVGPB4, Vol. 28, No. 3, p 277-295, August 1990. 2 fig, 128 ref.

Descriptors: \*Computer models, \*Computers, \*Groundwater movement, \*Hydrologic models, \*Literature review, \*Model studies, \*Simulation analysis, \*Solute transport, \*Supercomputers, Algorithms, Data interpretation, Mathematical models, Numerical analysis, Stochastic hydrology.

A literature review of recent applications of super-computers to solute transport problems is present-ed. These applications are based mostly on the assumption of a dilute solute, allowing the govern-ing equations to be decoupled. An application of supercomputers is the simulation of solute transsupercomputers is the simulation of solute trans-port in large heterogeneous spatial domains by both direct solution of the governing equations and by particle-tracking methods. One impetus for this research has been the rapid increase in predictive dispersion models based on analytical stochastic theory. Up until now, relatively few applications have incorporated algorithms designed with a tar-geted supercomputer in mind, with the result that the machine's potential has not been exploited geted supercomputer in mind, with the result that the machine's potential has not been exploited fully. Since many numerical problems are reduced to solutions of algebraic systems when they are implemented on computers, algorithms for linear algebraic systems of equations suitable for vector and parallel machines are discussed in some detail. Data analysis, necessary both for evaluating emerging theories and for more routine applications such as determining model parameters, is identified as another general area that is ably handled by supercomputers. In particular, supercomputers offer a way to become less dependent on parametric assumptions and constraints, substituting instead raw computational power. Visualization techniques and associated facilities have flourished alongside the development of supercomputer centers. These offer the possibility for real-time viewing of solute transport processes, both real and simulated, although little has been produced thus far. It is expected that many more researchers involved with subsurface solute transport will make use of supercomputers in the future. (Author's abstract) thor's abstract) W91-02543

TESTING EXPERT SYSTEM FOR ACTIVATED SLUDGE PROCESS CONTROL.

A.T. and T. Bell Labs., Naperville, IL. For primary bibliographic entry see Field 5D. W91-02573

BOUNDED IMPLICIT ENUMERATION FOR WASTEWATER-TREATMENT SYSTEMS.

North Carolina Agricultural and Technical State Univ., Greensboro. Dept. of Civil Engineering. For primary bibliographic entry see Field 5D. W91-02574

APPLICATION OF A DIGITAL GEOGRAPHIC DATA BASE TO IRRIGATION WATER RIGHTS MANAGEMENT.

Bureau of Reclamation, Denver, CO. Engineering

and Research Center.
For primary bibliographic entry see Field 6E. W91-02598

USING SATELLITE DATA FOR MAPPING AND MONITORING VEGETATION RESOURCES. R. H. Haas.

R. H. Haas.
IN: Remote Sensing Applications for Consumptive
Use (Evapotranspiration). Papers Presented at 21st
Annual AWRA Conference and Symposium,
August 11-16, 1985, Tucson, Arizona. AWRA
Monograph Series No. 6, (1985). p 51-64, 5 fig, 6
tab, 12 ref. USGS Contract No. 14-08-0001-20129.

Descriptors: \*Landsat images, \*Mapping, \*Satellite technology, \*Vegetation, Data acquisition, Data interpretation, Monitoring, Remote sensing, Resources management, Spectral analysis, Wyo-

Landsat multispectral scanner data are being used to map vegetation at a level useful to natural resource managers. A study conducted in the Big Horn Basin of north-central Wyoming demon-

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strates techniques that are helpful in producing a Landsat derived land cover map. Spectral stratifi-cation was used to gain precision in the use of the satellite data for mapping natural terrestrial vegeta-tion in a hierarchical physiognomic classification framework. Landsat spectral data were readily registered to a map base, and became an informa-tion source for this geographic information system tion source for this geographic information system application. Procedures were developed for mapping range capability classes with the Landsat derived vegetation and digitized soils data. The study suggests that the soil/vegetation landscape polygon could be used for monitoring changes in vegetative cover. The resulting change detection could be used in monitoring the status of land cover on large areas at minimal cost. (See also W91-02594) (Author's abstract)

WATER RESOURCES FOR CALIFORNIA, WATER YEAR 1989, VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE

Geological Survey, Sacramento, CA. Water Resources Div

Anderson, T. C. Hunter, and J. R. Mullen. W. Anderson, I. C. Hunter, and J. R. Mullen.
 Available from National Technical Information Service, Springfield, VA 22161 as PB90-258112/
 AS. Price codes: A19 in paper copy, A03 in micro-fiche. USGS Water-Data Report CA-89-3 (USGS/WRD/HD-90/284), 1990. 417p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: \*California, \*Data collections, \*Hydrologic data, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1989 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 3 contains discharge records for 182 gaging stations; stage and water contents for 47 lakes and reservoirs; water quality for 37 stations; and 3 crest-stage partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (USGS) W91-02624

WATER RESOURCES FOR FLORIDA, WATER YEAR 1989, VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.

Geological Survey, Miami, FL. Water Resources

Geological Survey, Miami, FL. Water Resources Div. W. J. Haire, and C. Price. Available from National Technical Information Service, Springfield, VA 22161 as PB90-263906. Price codes: A10 in paper copy; A02 in microfiche. USGS Water-Data Report FL-89-2A (USGS/WRD/HD-90/248), 1990. 204p. Prepared in cooperation with the State of Florida and other agen-

Descriptors: \*Data collections, \*Florida, \*Ground-water, \*Hydrologic data, \*Surface water, \*Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1989 water year in Water resources data for the 1989 water year in Florida consists of continuous or daily discharge for 295 streams, periodic discharge for 36 streams, miscellaneous discharge for 75 streams, continuous or daily stage for 154 streams, periodic stage for 13 streams, peak discharge for 57 streams, continuous daily tide stage for 12 streams, and peak stage for 30 streams, continuous or daily elevations for 72 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 514 wells, periodic ground-water levels for 514 wells, and miscellaneous water water levels for 514 wells, and miscellaneous water level measurements for 2,678 wells; quality of water data for 149 surface water sites and 827 wells. The data for South Florida include continuous or daily discharge for 61 streams, continuous

or daily stage for 80 streams, continuous elevation for 1 lake; continuous groundwater levels for 220 wells, periodic groundwater levels for 320 wells, and miscellaneous water level measurements for and miscellaneous water level measurements for 329 wells; quality-of-water for 3 surface-water sites and 545 wells. This data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (USGS) W91-02625

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1989, VOLUME 2B, SOUTH FLORIDA - GROUND WATER. Geological Survey, Miami, FL. Water Resources

Div. W. J. Haire, and C. Lietz.

W. J. Haire, and C. Lietz.

Available from National Technical Information
Service, Springfield, VA 22161 as PB90-258930.

Price codes: A18 in paper copy, A03 in microfiche.
USGS Water-Data Report FL-89-2B (USGS/WRD/HD-90/246), 1990. 403p. Prepared in cooperation with the State of Florida and other agen-

Descriptors: \*Data collections, \*Florida, \*Ground-water, \*Hydrologic data, \*Surface water, \*Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells

temperature, Wells.

Water resources data for the 1989 water year in Florida consist of continuous or daily discharge for 295 streams, periodic discharge for 36 streams, nescellaneous discharge for 75 streams, continuous or daily stage for 154 streams, periodic stage for 13 streams, peak discharge for 37 streams, continuous daily tide stage for 12 streams, and peak stage for 30 streams, continuous or daily elevations for 72 lakes, periodic elevations for 72 lakes, continuous groundwater levels for 514 wells, and miscellaneous water level measurements for 2,678 wells; quality of water data for 149 surface water sites and 827 wells. The data for South Florida include continuous or daily discharge for 61 streams, continuous or daily discharge for 80 streams, continuous elevation for 1 lake; continuous groundwater levels for 220 wells, periodic groundwater levels for 320 wells, and miscellaneous water level measurements for 39 wells, unality of functor for 3 streams, continuous and streams and services of 320 wells, and miscellaneous water level measurements for 39 wells; unality of functor for 3 streams, continuous elevation for 19 wells; unality of functor for 3 streams, continuous elevation for 19 wells; unality of functor for 3 streams, continuous elevation for 19 wells; unality of functor for 3 streams, continuous elevation for 19 wells; unality of functor for 3 streams, continuous elevation for 19 wells. wells, periodic groundwater levels for 320 wells, and miscellaneous water level measurements for 329 wells; quality-of-water for 3 surface-water sites and 345 wells. This data represent that the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (USGS) W91-02626

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1989, VOLUME 3A: SOUTH-WEST FLORIDA SURFACE WATER. Geological Survey, Tampa, FL. Water Resources

Div

Div. Available from National Technical Information Service, Springfield, VA 22161 as PB90-262296. Price codes: A14 in paper copy, A02 in microfiche. USGS Water-Data Report FL-89-3A (USGS/WRD/HD-90/266), 1990. 306p. Prepared in cooperation with the State of Florida and other agen-

Descriptors: \*Data collections, \*Florida, \*Ground-water, \*Hydrologic data, \*Surface water, \*Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1989 water year in Water resources data for the 1989 Water year in Florida consists of continuous or daily discharge for 295 streams, periodic discharge for 36 streams, continuous or daily stage for 154 streams, continuous or daily stage for 154 streams, continuous daily tide stage for 12 sites, periodic stage for 13 streams, peak discharge for 57 streams and peak stage for 30 streams; continuous or daily elevations for 73 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 514 wells, periodic groundwater levels for 514 wells, and miscellaneous water water levels for 798 wells, and miscellaneous water level measurements for 2,687 wells; quality-of-water data for 149 surface water sites and 827

wells. The data for Southwest Florida include records of stage, discharge and water quality of streams; stage, contents, water quality of lakes and reservoirs; and water levels and water quality of reservoirs; and water levels and water quality of groundwater wells. Volume 3A contains continuous or daily discharge for 99 streams, periodic discharge for 4 streams, miscellaneous discharge for 3 streams, continuous daily stage for 24 streams, continuous daily ide stage for 10 sites, periodic stage for 1 stream, peak discharge for 30 streams, continuous daily ide stage for 10 sites, periodic stage for 1 stream, peak discharge for 30 streams, continuous elevation for 12 lakes and periodic elevation for 16 lakes, and quality of water for 71 surface water sites. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (USGS) W91-02627

WATER RESOURCES FOR CALIFORNIA, WATER YEAR 1989, VOLUME 4: NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.

Geological Survey, Sacramento, CA. Water Resources Div.

S. W. Anderson, J. R. Mullen, and W. F. Shelton. S. W. Anderson, J. R. Mullen, and W. F. Shetton. Available from National Technical Information Service, Springfield, VA 22161 as PB90-266289. Price codes. A15 in paper copy, A02 in microfiche. Water-Data Report CA-89-4 (USGS/WRD/HD-90/301), 1990. 315p. Prepared in cooperation with the California Department of Water Resources and with other apercies. with other agenc

Descriptors: \*California, \*Data collections, \*Groundwater, \*Hydrologic data, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1989 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 4 contains discharge records for 177 gaing stations; stage and water contents for 34 lakes and reservoirs; precipitation data for 3 stations; and water quality for 9 stations. Also included is one low-flow partial-record station. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See also W90-06302) (USGS) W91-02628

WATER RESOURCES DATA FOR MASSACHU-SETTS AND RHODE ISLAND, WATER YEAR

Geological Survey, Boston, MA. Water Resources

R. A. Gadoury, R. S. Socolow, R. W. Bell, and T. J. Calderini.

J. Calderini.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-266297/
AS. Price codes: A11 in paper copy; A02 in microfiche. Water-Data Report MA-88-1 (USGS/WRD/HD-90/245), 1990. 231p. Prepared in cooperation with the States of Massachusetts and Rhode Island and with other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Massachusetts, \*Rhode Island, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1988 water year for Massachusetts and Rhode Island consist of stage, discharge and water quality of streams; contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 49 againg stations, monthend contents for 20 lakes and reservoirs. stations, monther contents for 20 takes and reservoirs, water quality for 9 gaging stations and water levels for 108 observation wells. Also included are data for one crest-stage partial-record station. Additional water data were collected at various sites, not part of the systematic data-collection program and are published as miscellaneous measurements.

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A few pertinent stations in bordering states are also included in this report. These data represent that portion of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Massachusetts and Rhode Island. (USGS) W91-02629

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1989, Geological Survey, Rolla, MO. Water Resources

Geological Survey, Rolla, MO. Water Resources Div. L. A. Waite, J. V. Davis, H. L. Reed, D. O. Hatten, and T. J. Perkins. Available from National Technical Information Service, Springfield, VA 22161 as PB90-262601. Price codes: A16 in paper copy, A02 in microfice. Water-Data Report MO-89-1 (USGS/WRD/HD-90/300), 1990. 353p. Prepared in cooperation with the State of Missouri and other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Missouri, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Sites, Water analysis, Water tempera-

The U.S. Geological Survey, Water Resources Division, in cooperation with local, State, and Federal agencies and organizations, obtains a large quantity of data pertaining to the water resources of Missouri each water year. These data, accumulated during many water years, constitute a valuable data base for developing an improved understanding of the water resources of Missouri. Water resources data for the 1989 water year for Missouri consist of records of stage, discharge and water quality of lakes and reservoirs. This report contains records for water discharge at 109 gaging stations; stage and contents at 11 lakes and reservoirs; water level records for 49 groundwater monitoring wells; water quality at 52 surface water sampling stations (Including 2 lakes); and data for 19 crest-stage stations. (USGS)

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1989.
Geological Survey, Helena, MT. Water Resources

Div. R. R. Shields, J. R. Knapton, M. K. White, T. M. Brosten, and J. H. Lambing. Available from National Technical Information Service, Springfield, VA 22161 as PB90-252362. Price codes: A25 in paper copy. A04 in microfiche. Water-Data Report MT-89-1 (USGS/WRD/HD-90/253), 1990. 562p. Prepared in cooperation with the State of Montana and with other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Montana, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for water year 1989 for Montana consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels in wells. This report contains discharge records for 246 gaging stations; stage/contents for 9 lakes and reservoirs; water quality for 109 stations, 3 lakes; water levels for 276 observation wells and 8 long-term observation wells equipped with continuous recorders. Also included are 53 smaller reservoirs. Additional water year 1989 data collected at crest-stage gage and miscellaneous measurement sites were collected but are not published in this report. These data are stored within the district office files in Helena and are available on request. These data represent part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Montana. (USGS) Water resources data for water year 1989 for Mon-

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1989, VOLUME 1: AT-LANTIC SLOPE BASINS, HUDSON RIVER TO

Geological Survey, West Trenton, NJ. Water Re-W. R. Bauersfeld, E. W. Moshinsky, E. A. Pustay, and W. D. Jones.

and W. D. Jones.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-252347.
Price codes: A16 in paper copy. A02 in microfiche.
Water-Data Report N1-39-1 (USG5/WRD/HD-90/289), 1990. 345p. Prepared in cooperation with the New Jersey Department of Environmental Protection and with other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*New Jersey, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for water year 1989 for New Jersey consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water contains discharge records for 73 gaging stations; tide summaries for 1 station; stage and contents for 15 lakes and reservoirs; water quality for 61 surface-water sites and 116 wells; and water levels for 69 observation wells. Also included are data for 39 crest-stage partial record stations, 11 tidal crest-stage gages, and 58 low flow partial record stations. Additional water data were collected at 54 sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Jersey. (See also W90-0840 and W91-02633) (USGS) Water resources data for water year 1989 for New

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1989, VOLUME 2: DELAWARE RIVER BASIN AND TRIBUTAR-IES TO DELAWARE BAY.

Geological Survey, West Trenton, NJ. Water Resources Div.

sources Div.

W. R. Bauersfeld, E. W. Moshinsky, E. A. Pustay,
and W. D. Jones.

Available from National Technical Information
Service, Springfield, VA 22161 as PB90-252370.

Price codes: Al1 in paper copy; A02 in microfiche.
Water-Data Report NJ-89-2 (USGS/WRD/HD90/290), 1990. 215p. Prepared in cooperation with
the New Jersey Department of Environmental
Protection and with other agencies.

Descriptors: \*Data collections, \*Groundwater, Hydrologic data, \*New Jersey, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for water year 1989 for New Water resources data for water year 1989 for New Jersey consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This volume of the report contains discharge records for 24 gaging stations; tide summaries for 3 stations; stage and contents for 18 lakes and reservoirs; water quality for 20 were the summaries and contents. contents for 18 lakes and reservoirs; water quality for 30 surface-water sites and 50 wells; and water levels for 55 observation wells. Also included are data for 23 crest-stage partial record stations, 2 tidal crest-stage gages, and 18 low-flow partial-record stations. Additional water data were collected at 10 sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Jersey. (See W90-06441 and W91-02632) (USGS)

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1989, VOLUME 2: LONG ISLAND.

Geological Survey, Syosset, NY. Water Resources

A. G. Spinello, J. H. Nakao, R. Busciolano, R. B. Winowitch, and V. K. Eagen.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-262619. Price codes: Al 0 in paper copy, Ao2 in microfiche. Water-Data Report NY-89-2 (USGS/WRD/HD-90/296), 1990. 196p. Prepared in cooperation with the State of New York and other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*New York, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Sampling sites, Sediments, Sites, Water analysis, Water temperature.

Water resources data for water year 1989 for New Vork consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This and water quality of groundwater wells. This volume contains discharge records for 17 gaging stations, water quality at 17 gaging stations, and 7 wells; and water levels at 225 observation wells. Also included are data for 74 low-flow partial-record stations. Additional water data were collected at various sites not involved in the systematic data collection program, and are published as miscellaneous measurements and analyses. These data, together with the data in Volumes 1 and 3 represent that part of the National Water Data System operated by the U.S. Geological Survey in cooperation with State, Federal and other agencies in New York. (USGS) W91-02634

WATER RESOURCES DATA FOR PENNSYL-VANIA, WATER YEAR 1989, VOLUME 2: SUS-QUEHANNA AND POTOMAC RIVER BASINS. Geological Survey, Harrisburg, PA. Water Re-

W. C. Loper, T. E. Behrendt, and W. P. Schaffstall.

Schaffstall.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-252271/
AS. Price codes: A13 in paper copy; A02 in microfiche. Water-Data Report PA-89-2 (USGS/WRD/HD-90/283), 1990. 289p. Prepared in cooperation with the State of Pennsylvania and other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Pennsylvania, \*Surface water, \*Water quality, Chemical analysis, Data collection sites, Flow rates, Gaging stations, Lakes, Reservoirs, Sediments, Streamflow, Water analysis, Water temperature.

Water resources data for water year 1989 for Penn-sylvania consist of records of discharge and water quality of streams; contents and elevations of lakes and reservoirs; and water levels and water quality quality of streams; contents and elevations of lakes and reservoirs; and water levels and water quality of groundwater wells. This report, Volume 2, includes records from the Susquehanna and Potomac River basins. Specifically, it contains: (1) discharge records for 90 continuous-record streamflow-gaging stations and 108 partial-record stations; (2) elevation and contents records for 13 lakes and reservoirs; (3) water quality records for 17 streamflow-gaging stations, for 10 ungaged streamsites, and for 14 wells or springs; and (4) water level records for 39 observation wells. Location of these sites are shown. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses and represent 20 special study and miscellaneous streamflow sites. These data together with the data in Volumes 1 and 3 represent that part of the National Water Data System operated by the U.S. Geological Survey in cooperation with State, Federal and other agencies in Pennsylvania. (USGS)

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1989.

Geological Survey, San Juan, PR. Water Resources Div. R. E. Curtis, Z. Aquino, R. J. Vachier, and P. L.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-258880. Price coes: A18 in paper copy, A03 in microfiche.

#### Field 7—RESOURCES DATA

# Group 7C—Evaluation, Processing and Publication

Water-Data Report PR-89-1 (USGS/WRD/HD-90/242), 1990. 420p. Prepared in cooperation with the State of Puerto Rico, the Government of the U.S. Virgin Islands and other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Puerto Rico, \*Surface water, \*Virgin Islands (US), \*Water quality, Aquifers, Chemical analysis, Flow rates, Gaging stations, Lakes, Sediments, Streamflow, Water analysis,

Water resources data for surface water, quality of water, groundwater records for the 1989 water year for Puerto Rico and the U.S. Virgin Islands, consist of records of discharge, water quality of streams, and water levels of wells. This report contains discharge records for 60 streamflow-gaging stations; 91 partial-record or miscellaneous streamflow, stations: stage records for 7 reservoirs. gaging stations; 91 partial-record or miscellaneous streamflow stations; stage records for 7 reservoirs; 1 crest-stage, partial-record streamflow station; water quality records for 16 streamflow-gaging stations, 42 ungaged streamsites, 11 lake sites, 2 lagoons, and 1 bay; and water level records for 76 observation wells. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating local and federal agencies in Puerto Rico and the U.S. W91-02636

WATER RESOURCES DATA FOR SOUTH CAROLINA, WATER YEAR 1989. Geological Survey, Columbia, SC. Water Re-

Geological Survey, Columbia, SC. Water Resources Div. T. W. Cooney, K. H. Jones, B. W. Church, and G. L. Murray.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-262304.

Price codes, A25 in paper copy, A04 in microfiche. Water-Data Report SC-89-I (USGS/WRD/HD/90/263), 1989. 385p. Prepared in cooperation with the State of South Carolina and with other agen-

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*South Carolina, \*Surface water, \*Water quality, Aquifers, Chemical analysis, Flow rates, Gaging stations, Lakes, Sediments, Streamflow, Water analysis, Water level.

Water resources data for the 1989 water year for Water resources data for the 1989 water year for South Carolina consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and levels of groundwater wells. This volume contains records for water discharge at 116 gaging stations, stage only at 22 gaging stations, stage and contents at 12 lakes and reservoirs, water quality at 61 gaging stations and water levels at 56 observation wells. Also included are data for 41 crest-stage partial-procord stations and discharge measurement inforrecord stations and discharge measurement infor-mation at 4 locations. Locations of these sites are shown. Additional water data were collected at various sites not involved in the systematic data collection program. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in South Carolina. (USGS) W91-02637

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1989. Geological Survey, Huron, SD. Water Resources

Geological Survey, Huron, SD. Water Resources Div.
M. J. Burr, R. D. Benson, and D. S. Hansen.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-262593.
Price codes: A17 in paper copp, A03 in microfiche. Water-Data Report SD-89-1 (USGS/WRD/HD-90/294), 1990. 383p. Prepared in cooperation with the State of South Dakota and with other agencies.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*South Carolina, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level. Water temperature

Water resources data for the 1989 water year for South Dakota consist of records of stage, dis-

charge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels in wells. This report contains discharge records for 147 streamflow-gaging stations; stage and contents records for 10 lakes and reservoirs, stage for 7 streams and 4 lakes; water quality records for 16 streamflow-gaging stations, 3 daily-sediment stations, 3 wells, 6 ungaged streamsites, 1 lake, 1 sewage lagoon, and 1 precipitation site; water levels for 30 wells; daily precipitation records at 38 sites; and 9 partial-record crest-stage gage sites. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperated that part of the National water Data System opera-ated by the U.S. Geological Survey and cooperat-ing State and Federal agencies in South Dakota. (USGS) W91-02638

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1989. VOLUME 2: SAN JA-CINTO RIVER, BRAZOS RIVER, SAN BER NARD RIVER BASINS AND INTERVENING NARD RIVER BAS COASTAL BASINS.

Geological Survey, Austin, TX. Water Resources

Div.

H. D. Buckner, W. J. Shelby, and H. J. Davidson.

Available from National Technical Information

Service, Springfield, VA 22161 as PB90-268574/

AS. Price codes: A18 in paper copy; A03 in microfiche. Water-Data Report TX-89-2 (USGS/WRD/HD-90/292), 1990. 412p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: \*Data collections, \*Hydrologic data, \*Surface water, \*Texas, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Sampling sites, Sediments, Streamflow, Water analysis, Water level.

Water resources data for the 1989 water year for Water resources data for the 1989 water year for Texas are presented in three volumes, appropriate-ly identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood-hydro-graph partial-record stations, reconnaissance par-tial-record stations, and low-flow partial-record stations. Additional water data were collected at stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States also are included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See also W91-02640) (USGS)

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1989. VOLUME 3: COLORADO RIVER, LAVACA RIVER, GUADALUPE RIVER, NUECES RIVER, RIO GRANDE BASINS AND INTERVENING COASTAL BASINS.

Geological Survey, Austin, TX. Water Resources

H. D. Buckner, W. J. Shelby, and H. J. Davidson.
Available from National Technical Information H. D. Buckner, W. J. Sheiby, and H. J. Davidson. Available from National Technical Information Service, Springfield, VA 22161 as PB90-268582, AS. Price codes: Al9 in paper copy; A03 in microfiche. Water-Data Report TX-89-3 (USGS/WRD/HD-90/293), 1990. 425p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: \*Data collections, \*Flow rates, \*Hydrologic data, \*Surface water, \*Texas, \*Water quality, Chemical analysis, Gaging stations, Lakes, Sampling sites, Sediments, Streamflow, Water analysis, Water level.

Water resources data for the 1989 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood-hydrograph partial-record stations, reconnaissance par-tial-record stations, and low-flow partial-record stations. Additional water data were collected at stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States also are included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See also W91-02639) (USGS) W91-02640

WATER RESOURCES DATA FOR WASHING-TON, WATER YEAR 1989.

Geological Survey, Tacoma, WA. Water Resources Div.

sources Div.

M. B. Miles, W. D. Wiggins, G. P. Ruppert, R. L. Blazs, and L. L. Reed.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-252354.

Price codes: A21 in paper copy, A03 in microfiche. Water-Data Report WA-89-1 (USGS/WRD/HD-90/285), 1990. 467p. Prepared in cooperation with the State of Utah and with other agencies.

\*Utah, \*Hydrologic data, \*Data collections, \*Surface water, \*Groundwater, \*Water quality, Streamflow, Lakes, Gaging stations, Chemical analysis, Sediments, Water analysis, Water levels, Flow rates, Sampling sites.

Water resources data for the 1989 water year for Washington consist of records of stage, discharge, and water quality of lakes and reservoirs; and water levels of wells. The report contains discharge records for 203 gaging stations; stage only records for 5 gaging stations; and stage and (or) contents for 55 lakes reservoirs; water quality for 33 streamflow-gaging stations, and 7 ungaged streamsites; water levels for 77 observation wells, and water quality for 1 observation wells, and water quality for 1 observation well. Also included are data for 5 crest-stage partial-record stations and 110 partial-record or miscellancious streamflow stations. Locations of these sites are shown. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Washington. (USGS)

OIL SLICK SIZES AND LENGTH OF COAST-LINE AFFECTED: A LITERATURE SURVEY AND STATISTICAL ANALYSIS-FINAL REPORT.

Minerals Management Service, Los Angeles, CA. Pacific OCS Region. For primary bibliographic entry see Field 5B. W91-02671

EVALUATION OF HYDROGEOLOGICAL PARAMETERS IN HETEROGENEOUS POROUS MEDIA.

Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Information Geologique. For primary bibliographic entry see Field 2F.

W91-02673

ESTIMATION OF THE TRANSMISSIVITY OF THE SANTIAGO AQUIFER, CHILE, USING DIFFERENT GEOSTATISTICAL METHODS. Pontificia Univ. Catolica de Chile, Santiago. Fac-

ulty of Engineering.
For primary bibliographic entry see Field 2F.
W91-02679

PREDICTION OF THE CONCENTRATION DISTRIBUTION OF GROUNDWATER POL-

Kyushu Univ., Fukuoka (Japan). Dept. of Civil Engineering. For primary bibliographic entry see Field 5B. W91-02684

# Evaluation, Processing and Publication—Group 7C

OUTLIERS IN GROUNDWATER QUALITY TIME SERIES.

Polish Academy of Sciences, Warsaw. Inst. of

Geophysics. Z. W. Kundzewicz, J. Ihringer, E. J. Plate, and J. Grimm-Strele.

Grimm-Strele.

IN: Groundwater Management: Quantity and Quality. Proceedings of the Symposium held at Benidorm, Spain, October 2-9, 1989. International Association of Hydrological Sciences, Washington, DC. 1989. p 161-169, 3 fig, 8 ref.

Descriptors: \*Data interpretation, \*Error analysis, \*Groundwater quality, \*Statistics, \*Time series analysis, Databases, Forecasting, Groundwater management, Hydrologic data collections, Water quality management, Water re-

The amount of groundwater quality data collected repetitively in several locations and pertaining to some dozens of parameters is very high. Therefore, in order to screen the data, a plausibility analysis of an incoming data point should be made before the point in question is accommodated into the data base. The problem of the detection of outliers in both in question is accommodated into the data sase. The problem of the detection of outliers in time series of non-equidistant groundwater quality data has been addressed. The operational check of data consistency, i.e., the procedure of judging if the newly acquired data element fits the temporal structure of the remainder of the data set, was used. This includes issuing the forecast of the variable in question, assessment of the variance of the forecast error, and checking if the newly incoming data point does not substantially depart from the forecast value. The methodology used is based on a modified exponential smoothing method which, in the problem considered, was more feasible than Kalman filtering and the geostatistics of temporal fields. Plausibility analysis of groundwater quality data is an important step in the building of databases necessary for decision making on water resources. (See also W91-02672) (Author's abstract) W91-02687

INTERACTIVE GROUNDWATER MODEL-LING: COLOUR GRAPHICS, ICAD AND AI. International Inst. for Applied Systems Analysis, Laxenburg (Austria). bibliographic entry see Field 2F.

INTEGRATED FINITE DIFFERENCE MODEL FOR GROUNDWATER FLOW AND QUALITY SIMULATION.

Bologna Univ. (Italy). Facolta di Ingegneria. For primary bibliographic entry see Field 2F. W91-02700

RELEVANCE OF THE TRANSPORT PARAMETERS IN PREDICTIVE MODELLING OF GROUNDWATER CONTAMINATION. Waterloo Univ. (Ontario). Inst. for Ground Water

For primary bibliographic entry see Field 5B. W91-02701

LOCALIZED ADJOINT METHODS: APPLICA-TION TO ADVECTION DOMINATED FLOWS. Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Geofisica. For primary bibliographic entry see Field 2F. W91-02702

FINITE ELEMENT COMBINED SURFACE WATER/GROUNDWATER MODEL FOR THE RIVER RHINE, KEHL/STRASBOURG RESER-VOIR

ahmeyer International G.m.b.H., Frankfurt am Main (Germany, F.R.).
For primary bibliographic entry see Field 5G.
W91-02716

APPLICATION OF GROUNDWATER MODEL-LING IN WATER RESOURCES MANAGE-MENT IN DENMARK. Miljoestyrelsen, Copenhagen (Denmark).

For primary bibliographic entry see Field 5B. W91-02719

MODELLING STREAMWATER CHEMISTRY AS A MIXTURE OF SOILWATER END-MEM-BERS-A STEP TOWARDS SECOND-GENERA-TION ACIDIFICATION MODELS. Senter for Industriforskning, Oslo (Norway). For primary bibliographic entry see Field 5B. W91-02753

MODELLING STREAMWATER CHEMISTRY AS A MIXTURE OF SOILWATER END-MEM-BERS-AN APPLICATION TO THE PANOLA MOUNTAIN CATCHMENT, GEORGIA, U. S. A. Geological Survey, Doraville, GA. Water Re-sources Div.

For primary bibliographic entry see Field 5B. W91-02754

REGIONAL MODEL OF ACIDIFICATION IN

WALES.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 5B.
W91-02759

ANALYSIS OF LONG-TERM SALINITY PAT-TERNS IN THE LOUISIANA COASTAL ZONE. Louisiana State Univ., Baton Rouge. Center for

For primary bibliographic entry see Field 2L. W91-02762

PROBABILITY MODEL FOR ACID RAIN DATA.

Canada Centre for Inland Waters, Burlington (On-For primary bibliographic entry see Field 5B. W91-02787

SENSITIVITY OF THE SURFACE HYDROLO-GY TO THE COMPLEXITY OF THE LAND-SURFACE PARAMETERIZATION SCHEME

SURFACE PARAMETERIZATION SCHEME EMPLOYED.

Macquarie Univ., North Ryde (Australia). School of Earth Science.

A. Henderson-Sellers, A. J. Pitman, and R. E.

Dickinson. Atmosfera ATMSEF, Vol. 3, No. 3, p 183-201, July 1990. 10 fig, 30 ref.

Descriptors: \*Atmospheric circulation, \*Climatology, \*Data interpretation, \*Hydrologic models, \*Model studies, \*Parametric hydrology, Carbon dioxide, Climatic changes, Diurnal variation, Hydrologic cycle, Precipitation, Solar radiation.

The sensitivity of surface hydrology to the parameterization scheme incorporated in three different atmospheric general circulation models (AGCMs) was investigated. It was found that the simulations of the surface hydrology by the NCAR Community Climate Model (CCM0) and GFDL models (which incorporate the bucket-type hydrological parameterization) differ markedly from the CCMiB model (which incorporate the Biosphere Atmosphere Transfer Scheme, BATS). The AGCMs which incorporate the simpler parameterizations of the land surface simulate a number of physical phenomena unrealistically. Many of these gross problems in the land surface climatology are eliminated in the CCMIB model which incorporates BATS. When present-day and doubled CO2 scenarios were compared, the differences between model results incorporating different surface scenarios were compared, the differences between model results incorporating different surface schemes were greater than the differences between 1 x and 2 x CO2. The implications of these results are that the surface hydrological fields from AGCMs, and their predictions of climatic change at the land surface, are likely to be unreliable. Investigations of the impact of climatic change consequent upon changes in the land surface climatic logy should employ one of the advanced parameterizations of the land surface coupled into the general circulation model, and develop and validate those components of the atmospheric model, such as the surface radiative forcing, regional pre-

cipitation patterns, and the diurnal cycle within the planetary boundary layer, that are most important for deriving land surface processes. (Author's abstract) W91-02804

MODELING TRANSIENT SUBSTRATE LOADS IN COMPLETELY MIXED AERATION BASINS AT HYDRAULIC STEADY STATE.

Vanderbit Univ., Nashville, TN. Dept. of Civil and Environmental Engineering.

For primary bibliographic entry see Field 5D. W91-02822

RELIABILITY ESTIMATION IN MODELING WATERSHED RUNOFF WITH UNCERTAIN-

Rutgers - The State Univ., Piscataway, NJ. Dept. of Civil and Environmental Engineering. For primary bibliographic entry see Field 2E. W91-02858

AQUIFER THERMAL ENERGY STORAGE: A NUMERICAL SIMULATION OF FIELD EXPERIMENTS IN CHINA.

Nanjing Univ. (China). Dept. of Earth Sciences. For primary bibliographic entry see Field 4B. W91-02866

SOME ANOMALOUS FEATURES OF FLOW AND SOLUTE TRANSPORT ARISING FROM FRACTURE APERTURE VARIABILITY. ROYal Inst. of Tech., Stockholm (Sweden). Dept. of Chemical Engineering.

For primary bibliographic entry see Field 2F. W91-02867

IDENTIFICATION OF LARGE-SCALE SPA-TIAL TRENDS IN HYDROLOGIC DATA. Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.

H. Rajaram, and D. McLaughlin Water Resources Research WRERAQ, Vol. 26, No. 10, p 2411-2423, October 1990, 7 fig. 2 tab, 36 ref. National Science Foundation Grants No. ECE-8514987 and 88-14615-CES.

Descriptors: \*Hydrologic data, \*Hydrologic properties, \*Model studies, \*Spatial distribution, \*Statistical analysis, \*Trend analysis, Algorithms, Estimating, Hydraulic conductivity, Hydrologic mating, Hydraulic models, Scale factors.

Distinguishing different scales of variability in hy-Distinguishing different scales of variability in hydrologic properties such as hydraulic conductivity is often useful. In the simplest two-scale case, large-scale variations can be viewed as a trend, while small-scale fluctuations about this trend can be viewed as a random residual. This paper describes a method for estimating spatial trends from scattered field measurements. The basic concept is to treat both the trend and the residual as stationary and company and company these functions are distinct. ary random functions, these functions are distin-guished by their spatial spectral (or covariance) properties, which may be estimated from available data or hypothesized. Two versions exist of a properties, which may be estimated from available data or hypothesized. Two versions exist of a general algorithm for estimating spatial trends: (1) a discrete version which is useful in practical applications where data are limited and irregularly spaced and (2) a continuous version which can be used to study the effects of using incorrect spectral parameters. Applications of the discrete algorithm to both synthetically generated data and field measurements yield satisfactory trend estimates. An analysis based on the continuous algorithm shows that the estimation error lower bound for these applications depends on two dimensionless ratios, that is, the scale disparity (ratio of the trend and residual correlation scales) and the signal-tonise ratio (ratio of the trend and residual variances). These ratios may be used to evaluate the feasibility of trend estimation before field samples are actually collected. Multiscale approaches to modeling and data collection can provide a practical and very flexible way to deal with natural variability. (Author's abstract)

# Group 7C—Evaluation, Processing and Publication

SOLUTION OF A NONLINEAR ABSORPTION MODEL OF MIXED SATURATED-UNSATU-RATED FLOW.
La Trobe Univ., Bundoora (Australia). Dept. of

For primary bibliographic entry see Field 2G. W91-02872

MODELING INFILTRATION INTO A SEAL-

Texas Agricultural Experiment Station, Lubbock. For primary bibliographic entry see Field 2G. W91-02878

COUPLED INVERSE PROBLEMS IN GROUNDWATER MODELING: 1. SENSITIVI-TY ANALYSIS AND PARAMETER IDENTIFI-

California Univ., Los Angeles. Dept. of Civil Engi-

neering. N. Z. Sun, and W. W. G. Yeh. Water Resources Research WRERAQ, Vol. 26, No. 10, p 2507-2525, October 1990. 3 fig. 11 ref, 54 ref, 3 append. National Science Foundation Grant No. 8814888.

Descriptors: \*Groundwater, \*Groundwater move-ment, \*Hydrological models, \*Mathematical models, \*Parameter estimation, \*Sensitivity analy-sis, Experimental design, Hydraulic conductivity, Optimization, Parameterization, Solutes.

Optimization, Parameterization, Solutes.

Because there are crossover effects between state variables and parameters, coupled inverse problems are different from single inverse problems in several aspects, especially in the selection of objective functions, identifiability, and experimental design. Parameter identification of coupled problems in groundwater modeling is defined as a vector optimization problem which can be solved by the weighting method. In order to obtain gradient vectors of objective functions as well as all sensitivity coefficients, the adjoint state method is extended to the case of coupled problems. Using derived rules, the adjoint equations of any nonlinear and transient coupled problem can be obtained. Sensitivity analyses based on the adjoint method are powerful tools for designing a reasonable experiment for solving the coupled inverse problem. The fact that hydraulic conductivities can be identified through the observation of solute concentration shows the possibility of using crossover effects in the solution of coupled inverse problems. (See also W91-02880) (Brunone-PTT)

COUPLED INVERSE PROBLEMS IN GROUNDWATER MODELING: 2. IDENTIFI-ABILITY AND EXPERIMENTAL DESIGN. California Univ., Los Angeles. Dept. of Civil Engi-

Water Resources Research WRERAQ, Vol. 26, No. 10, p 2527-2540, October 1990. 9 fig, 10 tab, 25 ref, append. National Science Foundation Grant No. CES 8814888. N. Z. SUn, and W. W. G. Yeh.

Descriptors: \*Experimental design, \*Groundwater models, \*Groundwater movement, \*Hydrologic models, \*Mathematical models, Estimating, Para-meterization, Parameters, Resource management.

Three new definitions of extended identifiability for a distributed parameter system are presented: interval identifiability, prediction equivalence identifiability. The uniqueness requirement of the inverse solution is relaxed by these definitions. An identified parameter is considered extendedly identifiable if it is able to satisfy an accuracy requirement in a specific application of the model. When a generalized least squares norm is used, the proposed identifiabilities are applicable to any coupled problems in which the state variables and parameters may have different order of magnitudes. A salient feature of the new definitions is that the extended identifiabilities are closely related to experimental design. Consequently, the sufficiency of an experimental design for assuring a given level of an extended identifiability can be estimated prior to Three new definitions of extended identifiability

field experiments. The methodology developed, linking experimental design, parameter identifica-tion, and management decisions can be used to determine the reliability of an experimental design even for nonlinear models. (See also W91-02879) (Author's abstract) W91-02880

APPLICATION OF THE ARNOLDI ALGO-RITHM TO THE SOLUTION OF THE ADVEC-TION-DISPERSION EQUATION. Manitoba Univ., Winnipeg. Dept. of Geological Engineering.
For primary bibliographic entry see Field 5B.
W91-02883

GAMMA-AUTOREGRESSIVE MODELS FOR STREAM-FLOW SIMULATION. Pontificia Univ. Catolica de Chile, Santiago. Dept. of Hydraulic Engineering. For primary bibliographic entry see Field 2E. W91-03925

HYDROGEOLOGIC ASSESSMENT OF EXPO-SURE TO SOLVENT-CONTAMINATED DRINKING WATER: PREGNANCY OUT-COMES IN RELATION TO EXPOSURE. Counter In Relation 10 EXPOSURE. California Univ., San Francisco. Dept. of Epidemiology and Biostatistics. For primary bibliographic entry see Field 5C. W91-02935

DECONTAMINATION TECHNOLOGIES FOR RELEASE FROM BIOPROCESSING FACILITIES: PART VI. VERIFICATION OF WASTEWATER DECONTAMINATION.
Battelle Memorial Inst., Columbus, OH. Environment Science Posts mental Science Dept.
For primary bibliographic entry see Field 5D.
W91-02937

### 8. ENGINEERING WORKS

### 8A. Structures

ATATURK NEARS COMPLETION.
9 Eylul Univ., Izmir (Turkey).
U. Ozis, E. Basmaci, and N. Harmancioglu.
International Water Power and Dam Construction
IWPCDM, Vol. 42, No. 9, p 12-16, September
1990. 10 fig, 21 ref.

Descriptors: \*Dam construction, \*Dams, \*Hydro-electric plants, \*Hydro-electric power, \*Rockfill dams, Atatur Dam, Embankments, Euphrates River, Hydrology, Spillways, Turkey, Water re-

The 184 m-high Ataturk rockfill dam is now almost complete. Impounding began in January 1990 and the first 300 megaWatt (MW) unit of the powerplant will go into operation in 1991. The last of the eight units is expected to begin operation before the end of 1993. The drainage area of the Euphrates at the Ataturk dam site is 92,338 sq km and the mean flow is estimated to be in the order 6 300 cm m/s. The diversion of the Euphrates and the mean flow is estimated to be in the order of 830 cu m/s. The diversion of the Euphrates River during construction of the dam was accomplished by upstream and downstream cofferdams and three tunnels through the left bank. An overflow spillway of 16,800 cu m/s capacity has been constructed. The embankment volume of 84.5 million cu m and reservoir volume of 48.5 cu km make Ataturk the largest dam in Turkey. The rockfill dam has a central clay core and a height of 184 m. The unit capacity is 300 MW; the scheme's total capacity of 2400 MW and energy generation of 8.9 TWh/year make it the largest hydroelectric plant in Turkey. (MacKeen-PTT)

SIR DAM AND POWERPLANT. 9 Eylul Univ., Izmir (Turkey). U. Ozis, H. Yanar, and M. Erdem. International Water Power and Dam Construction IWPCDM, Vol. 42, No. 9, p 17-18,20-21, September 1990. 6 fig, 10 ref.

Descriptors: \*Arch dams, \*Concrete dams, \*Dam construction, \*Dams, \*Hydroelectric plants, \*Hydroelectric power, Ceyan River, Embankments, Hydrology, Sir Dam, Spillways, Turkey, Water resources development.

resources development.

Sir dam, Turkey's third double curvature arch dam, is almost completed. The drainage area of the Ceyan River at the dam site is 12,950 sq km and the mean flow is estimated to be 130 cu m/s. The reservoir has a gross storage of 1.12 cu km and an active storage of 0.72 cu m. Diversion during construction was accomplished by the upstream and downstream cofferdams and a tunnel through the left bank. An overflow spillway has a capacity of 7460 cu m/s. The 120-m high double curvature concrete arch dam has a crest length of 325 m and a thickness of 5 m at the crest, 17.5 m at the foundation, and up to 25 m at the abutments. There are three intakes in the dam body, each serving a separate 66-m long penstock. The 55-m high powerhouse is designed for three 96.5 megaWatt units with an annual average generation capacity of 725 GWh/year. Impoundment began on 31 May 1990, and the first unit is expected to begin operation early in 1991. (MacKeen-PTT)

ADVANTAGES OF TURNKEY CONTRACTS IN HYDRO DEVELOPMENT,

HYDRO DE PERO INC.

P. Johannesson.

International Water Power and Dam Construction

IWPCDM, Vol. 42, No. 9, p 29-30, 32, 35-38,

September 1990. 14 fig, 10 tab, 4 ref.

Descriptors: \*Contracts, \*Cost analysis, \*Dam construction, \*Dams, \*Hydroelectric plants, \*Water resources development, California, Construction costs, Costs, Hydroelectric power, North Fork Stanislaus River Hydroelectric, Optimum development plans, Project planning, Sierra Nevada Mountains, Turnkey operations.

The Calaveras project, known formally as the North Fork Stanislaus River Hydroelectric Development Project, is in the Sierra Nevada Mountains, about 320 km east of San Francisco. It is a complex project involving seven tunnels (18 km total length), a 790 m shaft, two concrete gravity dams, one concrete-faced rockfill dam, one double curvature thin arch dam and two powerhouses. It was developed as a turnkey arrangement with Sierra Constructors as the contractor. Challenges at the bidding stage of the project included: increased Constructors as the contractor. Challenges at the bidding stage of the project included: increased concrete volume required at North Fork diversion dam; unfavorable rock foundation profile at saddle dam site; discovery of faults at saddle and main dam sites; lack of exploration at Beaver Creek dam, tunnel and penstock ares; foundation problems at McKay's dam site; and problems drilling the Collierville shaft. It took the owner 20 years and about \$16 million to obtain the FERC license, purchase the right-of-way, settle mitigation issues. and about \$16 million to obtain the FERC license, purchase the right-of-way, settle mitigation issues with Fish and Game and school recreational groups, and pay for legal services, engineering and environmental studies. The most unusual aspect of this turnkey project was the bidding phase, accomplished in only 6 mo. Construction time was fixed at 5 yr. A 2.5 yr time savings was realized, compared with estimates for conventional project development. Compared with conventional development costs, savings for turnkey development of Calaveras were \$23.5 million in interest payments, \$16.5 million for 2.5 yr early commissioning, and \$3.3 million in interest payments, \$16.5 million for 2.5 yr early commissioning, and \$89.2 million in construction costs. The total savings was about \$120 million. (MacKeen-PTT) W91-02114

USE OF THE GOULD PROBABILITY MATRIX METHOD OF RESERVOIR DESIGN IN ARID AND SEMI-ARID REGIONS.

Institute of Hydrology, Wallingford (England). Y. P. Parks, F. A. K. Farquharson, and D. T.

Finston.

IN: The State-of-the-Art of Hydrology and Hydrogoology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. Inter-

# Structures-Group 8A

national Water Resources Association, Urbana, Illinois. 1990. p 233-241, 3 fig, 1 ref.

Descriptors: \*Arid lands, \*Botswana, \*Reservoir capacity, \*Reservoir design, \*Semiarid lands, \*Streamflow forecasting, Design criteria, Gabarone Reservoir, Gould matrix method, Probability, Reservoir storage, Reservoir yield, Simulation.

Many methods are available for reservoir storage-yield design, but they rely on long inflow se-quences that are often scarce in arid and semi-arid regions. The Gould matrix method provides a technique that defines probability of failure and spill under specified withdrawal policies. The method does have some limitations, but it can provide much more sophisticated information that method does have some limitations, but it can provide much more sophisticated information that other commonly used techniques. In the case of the Gabarone (Botswana) reservoir, results employing the Gould matrix method show that if the reservoir is currently in a low zone at the start of the year, the likelihood of failure in the first few years is very high. As the initial reservoir water level increases, the short-term likelihood of failure is reduced. If the reservoir is at least half full, the probability of failure in the next few years progresses from zero to nearly 5%. It is possible to introduce rationing into the Gould procedure as part of the water balance. The results of five simulations based on an example from Great Britain show a decreasing yield as the probability of rationing increases with increase in return period of total failure. The same approach can be used to investigate the relationship between the return period of total failure with and without rationing, but with the same yield. (See also W91-02288) (Rochester-PTT)

HYDROLOGIC DESIGN AND DEVELOP-MENT OF HYDRAULIC STRUCTURES, Dar es Salaam Univ. (Tanzania). J. I. Matondo, and D. G. Fontane. IN: The State-of-the-Art of Hydrology and Hy-drogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouaga-dougou, Burkina Faso, 18-23 February 1989. Inter-national Water Resources Association, Urbana, Il-linois. 1990. p 306-319, 6 fig.

Descriptors: \*Africa, \*Dam design, \*Design crite-ria, \*Hydraulic engineering, \*Semiarid lands, \*Storage reservoirs, \*Water storage, Arid lands, Data collections, Developing countries, Hydraulic design, Sediment control, Sensitivity analysis, Sim-ulation, Water resources management.

In semi-arid areas the design of adequate water storage structures and distribution systems (i.e., small earth dams) is essential to deal with present and future water resources problems. Hydrologic and future water resources problems. Hydrologic data are lacking in most developing countries in the arid and semi-arid regions of Africa. Techniques used in the design of hydraulic structures when data are inadequate include sensitivity analysis with design simulation models, transfer of existing data from other locations, and synthetic generation of data based on watershed characteristics. Because settling the transfer in strength in research with the state of the st eration of data based on watershed characteristics. Because sediment trapped in reservoirs ultimately reduces their effectiveness, sediment control measures must be included in the design of dams and water diversion structures. Various sediment ex-clusion and ejection techniques exist (e.g., settling basins, guide walls and channel curvature, vortex basins, guide walls and channel curvature, vortex tube, guide vanes, tunnel excluders, combination sluice tunnel-settling basin excluder, combined re-lieving weir and silt ejector, and combined tunnel-guide vane ejector). Because economic difficulties exist in most countries in Africa, water resources projects must be planned and developed according to projected water needs. Techniques for optimal scheduling of projects have been developed. There is no substitute for collection of hydrology data. (See also W91-02288) (Author's abstract) W91-02312. (See also w W91-02312

INTERFLUX DAMS: THEIR ADVANTAGE FOR SAHARAN AND SAHELIAN AFRICA (LES BARRAGES D'INFEROFLUX: LEUR IN-TERET POUR L'AFRIQUE SAHARIENNE ET

Centre Univ. d'Avignon (France). Faculte des Sci-R Guirand

R. Gurraud.

In: The State-of-the-Art of Hydrology and Hydrogeology in the Arid and Semi-Arid Areas of Africa. Proceedings of the Sahel Forum, Ouagadougou, Burkina Faso, 18-23 February 1989. International Water Resources Association, Urbana, Illinois. 1990. p 320-329, 4 fig, 18 ref. English sum-

Descriptors: \*Africa, \*Arid lands, \*Dam design, \*Interflux dams, \*Sahara, \*Sahel, Alluvial fans, Climates, Design criteria, Developing countries, Groundwater recharge, Rural areas, Water resources development

Interflux dams and several related topics are discussed. First, the principle of subsurface dams and their advantages for improving water resources and quality are described. Mechanisms of the deposition and the preservation of alluvial fan deposits are discussed for both exorheic and endorheic basins. Climate variation and glacio-eustatic phenomena dominated these processes over the past 20,000 yr. Underflow and its exploitation in arid regions are discussed and examples analyzed from the Sahel, northern Africa, East Africa, and southern Africa. It is concluded that numerous small dams can be constructed in the Saharan and Sahelian regions that will allow both the accumulation lian regions that will allow both the accumulation of underground reserves and their recharge. In-creasing such dams would help to maintain rural settlement. (See also W91-02288) (Author's ab-W91-02313

PULSA SOLAR: SOLAR WATER OSCILLA-TION PUMPS FOR VILLAGE HYDRAULICS. Fluxinos Italia S.R.L., Grosseto. For primary bibliographic entry see Field 5F. W91-02347

SCIENTIFIC AND TECHNICAL EVALUATION OF MATHEMATICAL MODELS IN THE PLANNING DESIGN AND OPERATION OF HYDROSYSTEMS IN AFRICA.
New Tech International Inst., Dar es Salaam (Tan-

nary bibliographic entry see Field 2E. W91-02350

WATER RESOURCES MANAGEMENT IN NI-GERIA: THE RIVER BASIN APPROACH. Ibadan Univ. (Nigeria). Dept. of Geography. For primary bibliographic entry see Field 4A. W91-02357

ENVIRONMENTAL AND AGRICULTURAL IMPLICATIONS OF DAM CONSTRUCTION IN THE NIGER VALLEY OF MALL. Gesamthochale Paderborn (Germany, F.R.). For primary bibliographic entry see Field 6G. W91-02359

IMPACT OF HYDROLOGY ON HYDRAULIC PROJECTS IN BURKINA (IMPACT DE L'HY-DROLOGIE SUR LES PROJETS HYDRAULI-OUES AU BURKINA).

Ministry of Water Resources, Ouagadougou (Bur-kina Faso), Service de l'Hydrologie. For primary bibliographic entry see Field 6G. W91-02360

SLIPLINING RESCUES SEWERS AND A SMALL BUDGET.

L. C. Green, and J. Douglas.
Public Works PUWOAH, Vol. 121, No. 10, p 104-105, September 1990. 1 fig.

Descriptors: \*Conveyance structures, \*Economic aspects, \*Pipes, \*Rehabilitation, \*Sewer systems, Cost analysis, Costs, Pipelines, Sewers, South Carolina, Water conveyance.

Winnsboro, South Carolina sewer system serves 4,000 customers in the town, plus an additional

8,000 customers in surrounding Fairfield County. The sewer system, originally installed in the early 1930s, was showing signs of aging. The major problem was tree roots forcing their way into joints and cracks counting some problem was tree roots formy their way into joints and cracks, causing more cracks, allowing excessive sand and stormwater to seep into the system. Trenchless sewer rehabilitation technology involving insertion lining of the sewers, also called involving insertion liming of the sewers, also called sliplining, allowed the town to repair its sewer system on a very limited budget. Sliplining in-creased the sewer strength because liners with-stand temperatures up to 250 F, most chemicals and acids, and cannot be penetrated by roots. A service life of 50-100 years and low maintenance service lite of 30-100 years and low maintenance due to smooth plastic walls which require less cleaning, routing, and other work will provide long-term financial savings. Few traffic disruptions were necessary during installation because the sli-plining used lines already in place. To date, the project saved the town more than \$300,000 over pipe replacement costs. The biggest savings will be time saved that would otherwise have been used to maintain and service the old system. (Mertz-PTT) W91-02424

STUDY OF EMBANKMENT PERFORMANCE DURING OVERTOPPING AND THROUGH-FLOW. REPORT 1: FEASIBILITY STUDY.

Colorado Univ., Boulder. H.Y. Ko, R. J. Dunn, and E. Simantob Available from the National Technical Information Service, Springfield, VA 22161, as AD-A207755. Price codes: A05 in paper copy, A01 in microfiche. Miscellaneous Paper GL-89-5, April 1989. Report 1 of a Series. 76 p, 5 fig, 3 ref. Contract No. DACW39-83-C-0011.

Descriptors: \*Embankments, \*Flow profiles, \*Model studies, \*Overtopping, Banks, Clays, Dam failure, Data acquisition, Earth dams, Erosion, Hydrologic models, Performance evaluation, Photog-

raphy.

Overtopping of earth dams and embankments has resulted in great damage to property and facilities, and in some cases loss of life as well. Due to the large costs and possible consequences of full-scale overtopping studies and the limited accuracy of reduced scale models testing at natural gravity levels, testing of models in a centrifuge at increased gravity levels seems to be a suitable method for studying overtopping and erosion of earth embankments. Tests on model earth and crushed rock embankments using the University of Colorado Geotechnical Centrifuge have indicated the feasibility of this method of testing. Failure modes in the models agreed well with those observed in actual overtopping events. In crushed rock embankment erosion began at the toe and progressed rapidly upstream, eventually leading to breaching failure of embankments. In clay embankments, erosion occurred over the entire downslope area below the spillway crest, with no breaching of the crest occurring for the duration of overtopping flow utilized in the tests. Embankment erosion in flight was recorded using a closed circuit video camera and video tape and a pair of 35 mm SLR cameras, mounted to produce stere o pair photos of the embankment. Contour maps of the embankment. camera, mounted to produce stereo pair photos of the embankment. Contour maps of the embank-ment surface were produced from the stereo pairs. Photographic records were verified by manual measurements of the eroded surface. (See also W91-02608 and W91-02610) (Author's abstract) W91-02603

HYDRAULIC FRACTURE IN EARTH AND ROCK-FILL DAMS.

University of Western Ontario, London. Faculty of Engineering Science.

K. Y. Lo, and K. Kaniaru.

Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 4, p 496-506, August 1990. 13 fig, 1 tab, 20 ref. Natural Sciences and Engineering Research Council of Canada Grant No. OGP0007745.

Descriptors: \*Dam failure, \*Dam foundations, \*Hydraulic fracturing, \*Mathematical models, \*Model studies, \*Seepage, Consolidation, Saturation, Soil strength.

#### Field 8—ENGINEERING WORKS

## Group 8A-Structures

Unsatisfactory performance of earth and rock-fill Unsaisactory performance of earth and rock-nil dams involving excessive seepage, piping or failure has been attributed to hydrofracture of the core. Although the phenomenon has been reported for some time, important factors influencing hydraulic fracturing pressure, such as saturation and consolidation, have received relatively little attention; nor have results of laboratory tests or theoretical study been directly related to field performance. A labo-ratory testing program was made to determine the been directly restated to near performance. A saturatory testing program was made to determine the hydraulic fracturing pressure on compacted soil samples with grain-size distributions similar to those of the core materials used in construction of the dams in the case records. A simple theoretical the dams in the case records. A simple theoretical expression for fracture pressure was developed involving only conventional soil strength parameters. The results showed that hydraulic fracture pressure is not a unique soil property; its value depends on the degree of saturation and consolidation. A comparison of the data deduced from case records with test results and theoretical predictions indicates general consistency. The field hydraulic fracturing pressures are bounded in the upper limit by results from saturated-consolidated tests and in the lower limit by results of saturated-unconsolidated hydraulic fracturing tests. The methodology presented may be useful in the assessment of risk of hydraulic fracturing of dams. (Author's abstract) W91-02942

## 8B. Hydraulics

CHANGES IN SEASONAL SUCCESSION OF PHYTOPLANKTON INDUCED BY THE STORM-SURGE BARRIER IN THE OOSTERS-CHELDE (S.W. NETHERLANDS).

CHELDE S.W. NETHERANDS, Delta Inst. for Hydrobiological Research, Yerseke (Netherlands). For primary bibliographic entry see Field 2L. W91-02116

ENERGY RELATIONS IN TRANSIENT CLOSED-CONDUIT FLOW.

Toronto Univ. (Ontario). Dept. of Civil Engineer-

ing.
B. W. Karney.
Journal of Hydraulic Engineering (ASCE)
JHEND8, Vol. 116, No. 10, p 1180-1196, October
1990. 6 fig, 11 ref.

Descriptors: \*Closed-conduit flow, \*Energy conversion. \*Flow rates, \*Hydraulic properties, \*Pipe flow, \*Pipelines, \*Unsteady flow, Compressibility, Elasticity, Energy, Flow models, Friction, Kinetic energy, Mathematical analysis, Mathematical equations

When the rate of flow in a closed conduit is changed, large scale conversions of mechanical energy often occur, particularly if the pipeline is energy often occur, particularly if the pipeline is carrying water or some other slightly compressible liquid. Mathematical expressions describing these transient energy transformations are motivated from first principles and derived by mathematical manipulation of the governing continuity and momentum equations. The resulting expression accounts for the kinetic energy of the fluid, the internal energy associated with fluid compressibility and pipeline elasticity effects, the energy dissipated by friction, and the work done at the ends of the conduit. The energy approach provides an integrated view of transient conditions in the pipeline and is thus a simple, efficient, and logically consistent way of comparing the transient response consistent way of comparing the transient response of different systems and solution techniques. In particular, compressibility effects are shown to be negligible when the ratio of the change in internal energy to the change in kinetic energy is much less than one. This rule helps to distinguish the 'rigid water column' model of unsteady flow from the more complex water-hammer theory. (Author's abstract) W91-02522

CONTROLLING MECHANISM OF LOCAL

Royal Inst. of Tech., Stockholm (Sweden). Dept. of Hydraulics Engineering.
For primary bibliographic entry see Field 2J.

plates, 15 photos.

STUDY OF EMBANKMENT PERFORMANCE DURING OVERTOPPING AND THROUGH-FLOW, REPORT 1: FEASIBILITY STUDY.

Colorado Univ., Boulder. For primary bibliographic entry see Field 8A. W91-02603

NEW MADRID PUMPING STATION GRAVITY FLOW CONDUIT AND CONFLUENCE, NEW MADRID FLOODWAY, MISSOURI: HYDRAU-LIC MODEL INVESTIGATION.

LIC MODEL INVESTIGATION.

Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.

J. R. Leech.

Available from the National Technical Information Service, Springfield, VA 22161. Technical Report No. HL-90-12, September 1990. 112 p, 9 fig, 72

Descriptors: \*Conduits, \*Gravity flow, \*Hydraulic models, \*New Madrid Pumping Station, Channel flow, Channels, Hydraulic structures, Missouri, Pumping plants.

rumping plants.

Site-specific hydraulic model studies of hydraulic structures and channels on the New Madrid Flood-way, Missouri, were conducted to give three dimensional analyses of the open channels, to provide design information, and to minimize prototype cost. The proposed pumping station on the New Madrid Floodway consisted of a draft tube-type sump design, referred to as a formed suction inlet (FSI). The FSI has an advantage over conventional rectangular sumps by having a constantly decreasing cross-sectional area, which causes the flow to accelerate, eliminating vortices caused by geometry. A satisfactory FSI was developed by adding a cone section to the throat, which improved the dimensionless velocity contours. The riprap protection was found to be stable except for the area adjacent to the opening of the gravity rprap protection was found to be stable except for the area adjacent to the opening of the gravity flow intake. A plan was developed to correct the instability by replacing the original drop structure in the model, located at the confluence of the two channels, by a rip-rap lined channel, which provided satisfactory performance for all conditions tested. (Author's abstract)

YAZOO BACKWATER PUMPING STATION SUMP, WEST-CENTRAL MISSISSIPPI: HYDRAULIC MODEL INVESTIGATION.

Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Div. B. P. Fletcher

Available from the National Technical Information Service, Springfield, VA 22161. Technical Report No. HL-90-8, August 1990. 124 p, 9 fig, 2 tab, 83

Descriptors: \*Hydraulic models, \*Pumping plants, \*Sumps, \*Yazoo Backwater Pumping Station, Channel flow, Channels, Flow profiles, Hydraulic profiles, Hydraulic structures, Mississippi, Model studies, Vortices.

Numerical and physical hydraulic model tests were conducted to investigate the hydraulic perform-ance of the Yazoo Backwater Pumping Station approach channel, sump abutments, and sump. The numerical model was used as a tool for evaluating and screening various approach channel designs prior to testing in the physical models. Physical model tests were conducted in a 1:12.5-scale secmodel tests were conducted in a 1:12.5-scale sec-tion model and a 1:26-scale comprehensive model. non model and a 1:20-scale comprenensive model.

A variety of operating conditions with various water surface elevations were evaluated. In the section model, tests indicated that the intensity of the floor vortices increased as the suction bell moved closer to the floor. Various configurations of approach training walls were evaluated in the section model. In the 1:26-scale model, comprehensive tests were initially conducted to investigate section model. In the 1:2b-scale model, comprehen-sive tests were initially conducted to investigate hydraulic performance in a 15-pump, 17,500-cfs-capacity pumping station. Asymmetrical pump op-eration generated lateral approaches in the ap-proach channel, which generated an adverse flow distribution in the pump bays. Tests indicated that

a streamlined pump intake design compensated for adverse flows in the approach. At the request of the US Army Engineer District, Vicksburg, the the US Army Engineer District, Vicksburg, the capacity of the pumping station was reduced from a 17,500 to a 10,000 cfs station. Tests were conducted to refine the design of the streamlined sumply investigating various pump bay widths. Test results indicated that the pump bay widths could be reduced from 28 to 23 ft if vortex suppressor beams were installed in the pump bays. The adopted design developed from the model study should provide satisfactory hydraulic performance for anticipated flow conditions. (Author's abstract) W91-02660

STUDY OF EMBANKMENT PERFORMANCE DURING OVERTOPPING AND THROUGH-FLOW. REPORT 2: HYDRAULIC STUDY AND MODELING OF MODELS.

Colorado Univ., Boulder. Colorado Univ., Boulder.
H. Y. Ko, J. Dunn, and E. Simantob.
Available from the National Technical Information
Service, Springfield, VA 22161, as AD-A207756.
Price codes: A04 in paper copy, A01 in microfiche.
Miscellaneous Paper GL-89-5, April 1989. Report
2 of a Series. 65 p, 5 fig, 5 tab, 3 ref. DOA
Contract DACW39-83-C-0011.

Descriptors: \*Embankments, \*Erosion, \*Model studies, \*Overtopping, Earth dams, Flow velocity, Hydraulic models, Performance evaluation.

An experimental program involving three rigid and three erodible model embankments is de-scribed. The rigid embankments are constructed of aluminum and are used to evaluate flow quantity, scribed. The rigid embankments are constructed of aluminum and are used to evaluate flow quantity, measure resulting water velocities, and perform a model study. Erodible embankment models were constructed of characteristic soils and were used to evaluate and document erosion in the scale models. The three scaling ratios used during this study were 1:24 scale, 1:49 scale, and 1:71 scale for both the rigid and erodible embankments. The system which delivered the overtopping water to the model is described along with other details of the centrifuge equipment, specimen preparation and testing techniques. A total of seven tests were performed during which erosion rates were documented and time scaling factors determined. This study confirmed that model behavior duplicated field behavior at least qualitatively in that erosion (as the result of overtopping) begins at the toe of the slope of an embankment then progresses upslope and through the crest as complete breach is observed. (See also W91-02603 and W91-02610) (Author's abstract)

STUDY OF EMBANKMENT PERFORMANCE DURING OVERTOPPING AND THROUGH-FLOW. REPORT 3: MODEL-PROTOTYPE COMPARISON STUDIES.

COMPARISON STUDIES.
Colorado Univ., Boulder.
H. Y. Ko, R. J. Dunn, and T. Hollingsworth.
Available from the National Technical Information
Service, Springfield, VA 22161, as AD-A207954.
Price codes: AU5 in paper copy, A01 in microfiche.
Miscellaneous Paper GL-89-5, April 1989. Report
3 of a Series. 81 p., 39 fig. 3 ref, append. DOA
Contract DACW39-83-C-0011.

Descriptors: \*Embankments, \*Erosion, \*Model studies, \*Overtopping, \*Soil properties, Cohesive soils, Dam failure, Earth dams, Flow velocity, Hydraulic models, Performance evaluation.

An attempt was made to model two well documented embankment overtoppings: the Clarence Cannon and Bloomington Lake overtopping failures. The results of modeling in two dimensions versus modeling in three dimensions were investigated, along with a study of the effects of nonhomogeneous embankment cross sections on erosion. Centrifuge modeling of Clarence Cannon and Bloomington Lake overtopping events consisted of four tests each at 1:80 full scale. Materials used were fairly noncohesive and cohesive soils in an attempt to bracket prototype behavior rather than to duplicate a precise event. During testing, the centrifuge was repeatedly started and stopped in

# Hydraulic Machinery-Group 8C

order to take measurements of erosion resulting from overtopping. Agreement between scale models and documented prototype behavior was not especially good, but the study did confirm that noncohesive soils are considerably more erodible than cohesive materials in terms of their ability to than cohesive materials in terms of their ability to withstand extended periods of overtopping without destruction. The attempt to evaluate the appropriateness of two-dimensional versus three-dimensional embankment modeling was inconclusive because of the interaction of the two dimensional models with the boundaries. The study did confirm that zoned embankment structures, once compromised, are much more erodible and susceptible to destruction than homogeneous structures. (See W91-02603 and W91-02608) (Author's abstract) W91-02610 and W91-02608) (Author's abstract)

SPLIT OF TWO-PHASE FLOW AT A HORIZONTAL T-ANNULAR AND STRATIFIED FLOW.

FLOW. UKAEA Atomic Energy Research Establishment, Harwell (England). Thermal Hydraulics Div. B. J. Azzopardi, D. Wagstaff, L. Patrick, S. B. Memory, and J. Dowling. Report AERE R13059, May 1988. 56 p. 22 fig, 4 tab, 22 ref.

Descriptors: \*Annular flow, \*Hydraulic profiles, \*Pipe flow, \*Stratified flow, Flow profiles, Hydraulics, Pressure, Split flow.

Experiments were carried out for wavy-stratified and annular flows approaching a horizontal T-junction, as well as flows at the boundary between these two patterns. Data were obtained over an entire range of gas take-off pressures through the side arm. The effects of side arm diameter, system pressure and gas momentum were studied systematically, in addition to visualization experiments which were carried out at the investigation. atically, in addition to visualization experiments which were carried out as the junction was viewed from several directions simultaneously. The data were used to test some predictive methods. Study conclusions are that: (1) data on the flow split of annular and stratified flow by a horizontal junction show regular and systematic trends; (2) the flow split depends strongly on the inertia (or momentum) of the phases; and (3) the flow split is effected by gas flow rate, liquid flow rate, gas density and the ratio of the side arm to main tube diameter. (I.antz-PTT) (Lantz-PTT) W91-02613

ENVIRONMENTAL RIVER ENGINEERING. University of East Anglia, Norwich (England). School of Environmental Sciences. For primary bibliographic entry see Field 4A. W91-02845

HEAD LOSSES IN STORM SEWER MAN-HOLES: SUBMERGED JET THEORY. HOLES SUBMERGED JET THEORY.
Technical Univ. of Denmark, Lyngby. Inst. of
Hydrodynamics and Hydraulic Engineering.
F. B. Pedersen, and O. Mark.
Journal of Hydraulic Engineering (ASCE)
JHEND8, Vol. 116, No. 11, p 1317-1328, November 1990. 9 fig, 6 ref.

Descriptors: \*Head loss, \*Hydraulic engineering, \*Sewer systems, \*Storm sewers, \*Submerged jets, Jets, Manholes, Mathematical analysis, Pipes, Pres-

The design of storm sewers especially suffers from lack of knowledge of the head losses in manholes. A submerged jet theory for the flow in manholes with straight throughflow has been developed. The entrance head loss is related to the kinetic energy transformation associated with the entrainment/detrainment in the jet. The exit head loss is calculated as a Carnot-loss in connection with the vena contracta in the exit pipe. The jet theory and experiments show that the only governing parameter for a specific manhole shape is the ratio of manhole diameter to pipe diameter. The theory has been compared to laboratory experiments. The head loss in storm sewer manholes was shown to be considerably smaller than the values calculated by traditional formulas. (Author's abstract)

EXPLICIT CALCULATION OF PIPE-NET-WORK PARAMETERS. Kentucky Univ., Lexington. Dept. of Civil Engi-

neering.
P. F. Boulos, and D. J. Wood.
Journal of Hydraulic Engineering (ASCE)
JHEND8, Vol. 116, No. 11, p 1329-1344, November 1990. 2 fig. 8 tab, 10 ref, 3 append. National
Science Foundation grant ECE-861205.

Descriptors: \*Hydraulic engineering, \*Network design, \*Pipe flow, \*Pipes, \*Steady flow, Algorithms, Calibrations, Mathematical equations, Numerical analysis, Water pressure.

An iterative solution of the full set of continuity and energy equations provides a powerful technique for the determination of steady-state pressure and flow conditions in pipe networks. An explicit algorithm is presented for directly determining a variety of design, operating, and calibration parameters for pipe networks. The problem solution is based on the reformulation of the steady-state network equilibrium equations in terms of specified pipe-system parameters. Since these equations are nonlinear, the incremental Newton-Raphson method is used as the basic solution procedure. A continuous variable space is assumed for the various parameters, which are selected to exactly satisfy stated pressure and flow requirements at critical nodes and pipes throughout the pipeline systems for a range of operating conditions. This approach offers a basis for determining the optimum values for the various design, operating, and calibration parameters in the sense that the parameters can be calculated to exactly meet the specified pressure and flow constraints. All types of pipe distribution systems can be considered. The solution space is secured through a well-arranged interaction between network topology, boundary constraints, and network parameters. The feasibility and flexibility of the proposed approach were demonstrated successfully using an example network (Author's An iterative solution of the full set of continuity bility of the proposed approach were demonstrated successfully using an example network. (Author's abstract) W91-02917

MODELING CHANNEL BED TRANSIENTS USING EXPLICIT F-D SCHEMES, Ottawa Univ. (Ontario). Dept. of Civil Engineer-

For primary bibliographic entry see Field 2E. W91-02918

RESISTANCE TO FLOW IN STEEP ROUGH STREAMS.
Universidad de Los Andes, Merida (Venezuela).

Dept. of Civil Engineering. For primary bibliographic entry see Field 2E. W91-02920

FIRST STEP AWAY FROM LACEY'S REGIME

FIRST SIEP AWAY FROM LACEY'S REGIME EQUATIONS,
M. A. Stevens, and C. F. Nordin.
Journal of Hydraulic Engineering (ASCE)
JHENDS, Vol. 116, No. 11, p 1422-1425, November 1990. 1 fig, 1 tab, 9 ref.

Descriptors: \*Alluvial channels, \*Canal design, \*Channel morphology, \*Hydraulic engineering, \*Mathematical equations, \*Sediment transport, Channel flow, Regime channels, River mechanics,

The problem of designing stable canals is in determining what nature would choose for the width, depth, and bed slope of the channel to convey both water and sediment from one point to another if the water and sediment are to flow in a self-formed alluvial channel, when the design discharge and an accompanying sediment concentration of known size are given. Lacey's regime equations explicitly address all issues except rate of sediment transport. The substitution of the sediment concentration in place of Lacey's silf factor is a simple improvement The substitution of the sediment concentration in place of Lacey's silf actor is a simple improvement to Lacey's equations because it is a first step toward reformulating the design equations more rigorously on the basis of conservation laws and Newton's laws of motion. As with Lacey's equations, the new set has very limited application. They are for 0.1-0.3-sand; concentrations are less

than 100 mg/L; the velocity should be within 0.5-2.5 ft/sec (0.14-0.75 m/s); and the bank material must have enough strength to resist erosion by these velocities. For conditions outside these limitations, another set of regime equations must be developed. (Fish-PTT) W91-02924.

## 8C. Hydraulic Machinery

DEVELOPMENT OF TURKEY'S ELECTRIC

State Hydraulic Works, Ankara (Turkey). F. Anik.

International Water Power and Dam Construction IWPCDM, Vol. 42, No. 9, p 9-10, September 1990.

Descriptors: \*Electric power production, \*Hydro-electric plants, \*Hydro-electric power, \*Turkey, \*Water resources development, Administrative agencies, Electric power demand, Future planning,

Turkey has 4200 megaWatts (MW) of hydroelectric power presently under construction, and a further 6799 MW planned for projects to be implemented after 1991. The State Hydraulic Works inented after 1991. The State Hydraulic Works (DSI-Devilet Su Isleri) and the Turkish Electricity Authority (TEK-Turkiye Elektrik Kurumu) are the principal organizations which distribute elec-tric energy in Turkey. The DSI was established in the principal organizations which distribute feettric energy in Turkey. The DSI was established in
1953 as a public organization for the development
of surface water and groundwater resources in
Turkey. After construction of a hydroelectric
power plant has been completed, operation becomes the responsibility of TEK. Since the government terminated the monopoly in electric
power of TEK in 1984, the private sector has been
licensed to construct and operate 20 hydro plants
with a total installed capacity of 2062 MW. Turkey
covers an area of 779,500 sq km and has an estimated average annual runoff of 186 sq km from its 26
river basins. At present 477 hydropower projects,
with a total installed capacity of 34,892 MW, have
been studied in Turkey either at masterplan level
or to the feasibility stage. Of the current total
average annual production of 24,293 gigaWatts
(GW), 73% is produced at the five largest stations.
According to the latest forecast, electric energy According to the latest forecast, electric energy generation is likely to increase by 8.5% per year on average until the year 2010. (MacKeen-PTT) W91-02110

ATATURK NEARS COMPLETION, 9 Eylul Univ., Izmir (Turkey). For primary bibliographic entry see Field 8A. W91-02111

SIR DAM AND POWERPLANT. 9 Eylul Univ., Izmir (Turkey). For primary bibliographic entry see Field 8A. W91-02112

MONITORING SYSTEM FOR DETECTING MOVEMENTS OF PENSTOCK SUPPORTS. MOVEMENTS OF PENSIOCK SUPPORTS.
Waagner-Biro A.G., Graz (Austria). Research and
Development Centre.
For primary bibliographic entry see Field 8G.
W91-02113

ADVANTAGES OF TURNKEY CONTRACTS IN HYDRO DEVELOPMENT. For primary bibliographic entry see Field 8A. W91-02114

SOVIET DESIGN OF LARGE TURBINES FOR WIDE HEAD RANGES. W/O Hydroproject, Moscow (USSR).
M. F. Krasilnikov, and V. A. Linyuchev.
International Water Power and Dam Construction
IWPCDM, Vol. 42, No. 8, p 34-35, 38-39, August

Descriptors: \*Dams, \*Hydraulic machinery, \*Hydroelectric plants, \*Turbines, \*USSR, Design cri-

# Field 8—ENGINEERING WORKS

# **Group 8C—Hydraulic Machinery**

teria, Economic aspects, Hydraulic equipment, Hydraulic structures, Hydraulic turbines, Hydroelec-

The staged construction of large scale projects in the USSR can make a substantial contribution to the return on capital investment because of the large amount of extra electricity which can be produced during the initial low-head stage. This poses new challenges for the design of electrome-chanical equipment to operate over a wide head chanical equipment to operate over a wide head range. Three types of equipment are used in such cases, selected on the basis of a technical and economical feasibility study for the specific condi-tions of the project site. A turbine with a wide range of allowable operating heads may be select-ed (such as a Kaplan, Francis, or Deriaz turbine), temporary runners with an increased specific speed may be installed for the period of operation at low heads or throughest generators may be installed may be installed for the period of operation at low heads, or two-speed generators may be installed. All three of these options have been used success-fully for large scale projects in the USSR. Diago-nal flow turbines for operation under a wide range of heads have been installed at the Zeya and Kolyma hydropower plants. Temporary runners in Francis turbines have been installed at Nurek and Sayano-Shushensk, and two-speed generators were installed at the Rogun dam project. Although all of these schemes involve some unrecoverable costs, the power generated during the low-head phase will normally justify the additional expense. (Tappert-PTT) W91-02155

NEW APPROACH TO TURBINE SPEED.

Monenco Consultants Ltd., Montreal (Quebec). J. L. Gordon.

International Water Power and Dam Construction IWPCDM, Vol. 42, No. 8, p 39, 41-43, 46, August 1990. 2 fig, 4 tab, 4 ref.

Descriptors: \*Hydraulic machinery, \*Hydraulic turbines, \*Hydroelectric plants, \*Turbines, Estimating equations, Hydraulic equipment, Hydraulic structures, Hydroelectric power.

Current practice in the turbine industry for detercurrent practice in the turbine moustry for deter-mination of turbine speed is to develop empirical formulae for each type of turbine, relating specific speed to the net head. Turbine runner speed thus becomes a function of head, diameter, and runner throat velocity. Both the number of runner blades and the runner speed have an influence on the turbine speed. By including the number of runner blades and the type of draft tube, it is possible to develop a more accurate equation for speed, with one equation covering all types of reaction (pit, bulb, Kaplan, propeller, and Francis) turbines. The new equation is based on an analysis of 155 turbine new equation is based on an analysis of 155 turbine units. By including the number of runner blades or buckets, and a factor for the type of draft tube, accuracy of the equation is within plus or minus 15 per cent for 88 per cent of the units. The database includes turbine heads ranging from 3 m to 500 m, throat diameters from 1 m to 9 m, throat velocities from 6 m/s to 14 m/s, blade numbers from 3 to 19. from 6 m/s to 14 m/s, blade numbers from 3 to 19, and runner speeds from 50 to 750 rev/min. With a larger database, including more high head, high speed Francis units, the equation could be refined further to increase accuracy. The new speed equation is not proportional to the square root of flow. (Tappert-PTT)
W91-02156

BEHAVIOUR OF FRANCIS UNITS UNDER PARTIAL LOADS.

Universidad Nacional Autonoma de Mexico,

Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ingenieria.

J. L. Sanchez Bribiesca, R. B. Carmona Paredes, and L. Carmona Paredes.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 8, p 46-47, 49-52, August 1900 0.65; 3. beb. 8-of. 1990. 9 fig. 2 tab. 8 ref.

Descriptors: \*Hydraulic machinery, \*Hydraulic turbines, \*Hydroelectric plants, \*Mexico, \*Turbines, Electrical equipment, Hydraulic equipment, Hydraulic structures, Hydroelectric power, Performance evaluation, Pressure-measuring instru-

A study of four Mexican powerplants with Francis turbines examined turbine behavior working under partial loads. The study included a literature review, laboratory experiments, and field prototype measurements. Previous studies suggest that because of the forced vortex core precession. because of the forced vortex core precession movement, hydroelectric power systems are subject to the action of pulsating pressures with frequencies from 25 to 50 per cent of the turbine rotational speed. Pressure transducer data collected at four hydroelectric plants identified pressure ed at four hydroelectric plants identified pressure fluctuations with frequencies of about 25 per cent of the turbine rotational speed when the discharge through the turbines was close to half of the design discharge. When the discharge was in the range of 25 to 35 per cent of the design discharge, and the total head was close to or larger than the design head, higher pressure fluctuations were produced in three of the four plants with frequencies beyond the predicted range. Laboratory data collected from two yortex generators suggested that to the predicted range. Laboratory data collected from two vortex generators suggested that to attain large head pressure fluctuations it is not sufficient for one of the exciter frequencies to fit with the system main frequency, but it is necessary to get a certain combination of head and discharge acting simultaneously. A simple procedure has been developed based to be a simple procedure has to get a certain combination of head and discharge acting simultaneously. A simple procedure has been developed, based upon the transfer matrix method, to predict the behavior of hydroelectric machinery under diverse operating conditions. The numerical results are in good agreement with field prototype measurements. (Tappert-PTT) W91-02157

UPGRADING PROCUREMENT SPECIFICA-TIONS FOR HYDROELECTRIC MACHINES.

Harza Engineering Co., Chicago, IL. R. W. Fazalare. International Water Power and Dam Construction IWPCDM, Vol. 42, No. 8, p 54-56, August 1990. 2

Descriptors: "Hydraulic equipment, "Hydraulic machinery, "Hydroelectric plants, "Mechanical enjencering, "Testing procedures, "Turbines, Computer models, Design criteria, Electrical equipment, Finite element method, Hydraulic structures, Hydraulic turbines, Hydroelectric power.

Specifications for large custom-designed hydraulic Specifications for large custom-designed hydraulic machines are in urgent need of upgrading. These typically specify the structural integrity around a nominal design stress of the material, and the hydraulic design around laboratory model tests based on similar units. However, advanced tools available today, such as computer-based finite element analysis, fracture mechanics analysis, and computer-based finite element analysis, fracture mechanics analysis, and computer-based finite element. able today, such as computer-based finite element analysis, fracture mechanics analysis, and computer modeling of flow and dynamic behavior, are considered mandatory in the modern design of custom hydro machines. In view of the lack of formally adopted guidelines these new design techniques should be required in the specifications, with the detailed design criteria to be agreed between the manufacturer and the engineer. The integrated design analysis should include cyclic loading for a 50 year machine life, a finite element analysis of all major components to determine stress level and material requirements, a fracture mechanics analysis of all major components to determine critical size defect and crack growth propagation rate as well as fatigue stress levels, a dynamic vibration analysis determining amplitude and frequency of each major component, a dynamic analysis of the unit's rotating system covering running clearances, bearing spring constants, etc., and a series of computer model simulation flow analyses to optimize the hydraulic design of the turbine runner and the distribution and cascading of flow through the guidevanes, spiral case and draft tube. (Tappert-PTT)

COMPUTER-CONTROLLED WELL FIELD AND DISTRIBUTION SYSTEM. Browne (Floyd) Associates Ltd., Marion, OH. For primary bibliographic entry see Field 5F.

NEW MADRID PUMPING STATION GRAVITY FLOW CONDUIT AND CONFLUENCE, NEW MADRID FLOODWAY, MISSOURI: HYDRAU-LIC MODEL INVESTIGATION.

Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab. For primary bibliographic entry see Field 8B. W91-02605

YAZOO BACKWATER PUMPING STATION SUMP, WEST-CENTRAL MISSISSIPPI: HYDRAULIC MODEL INVESTIGATION. Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Div. For primary bibliographic entry see Field 8B. W91-02606

TURBINE-INTAKE FISH-DIVERSION Iowa Inst. of Hydraulic Research, Iowa City For primary bibliographic entry see Field 8I. W91-02915

#### 8D. Soil Mechanics

FOUNDATION PROBLEMS IN CHAMPLAIN CLAYS DURING DROUGHTS, I: RAINFALL DEFICITS IN MONTREAL (1930-1988). Ecole Polytechnique, Montreal (Quebec). Dept. of

Civil Engineering.
V. Silvestri, M. Soulie, J. Lafleur, G. Sarkis, and

V. Silvestri, M. Soulie, J. Dancari, S. Dancari, M. Bekkouche.
Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 3, p 285-293, June 1990. 6 fig, 3 tab, 36 ref.

Descriptors: \*Clays, \*Drought effects, \*Evapo-transpiration potential, \*Expansive clays, \*Montre-al, \*Precipitation, \*Rainfall, \*Soil mechanics, \*Soil water, Drought, Evapotranspiration, Foundation failure, Roots, Vegetation effects, Water deficit.

Historically, damage to lightweight buildings in eastern Canada has often resulted from soil volume changes beneath shallow foundations, due to sea-sonal moisture variation and clay shrinkage caused sonal moisture variation and clay shrinkage caused by tree roots. During the exceptionally dry summer of 1983, extensive settlement problems developed in lightweight buildings founded in the clay deposits of the Montreal area. A modified budget that keeps a running balance of precipitation and potential evapotranspiration (PET) is applied to the region of study to obtain the soil moisture depletion or rainfall deficit throughout the period 1930-1988. Potential evapotranspiration was estimated using the methods of Thornthwaite, Penman, Blaney and Criddle, and Turc. The Blaney and Criddle method provides the highest estimate for PET. Detailed monthly rainfall deficits were calculated using the method of Thornthsetimate for PET. Detailed monthly rainfall deficits were calculated using the method of Thornthwaite. Based upon that method, a rainfall deficit of
170 mm/month is proposed as a threshold value.
Above this value, foundation problems are likely
to occur in the shrinkable eastern Canadian clays.
Different limiting values of the rainfall deficit
would be calculated by the other three methods.
By calculating the rainfall deficit it is possible to
predict whether a particular summer will be relatively wet or relatively dry, and take corrective
measures if necessary. Because the climatic and soil
conditions in Montreal are similar to those in the
St. Lawrence Lowlands, it is believed that these
findings apply equally well to those regions. (Tappert-PTT)
W91-02147

PORE PRESSURE FIELD BUILT UP IN A RAPIDLY ERODED SOIL MASS.
Basilicata Univ., Potenza (Italy). Ist. di Geologia e

G. B. Fenelli, and L. Picarelli.
Canadian Geotechnical Journal CGJOAH, Vol.
27, No. 3, p 387-392, June 1990. 11 fig, 10 ref.

Descriptors: \*Clays, \*Erosion, \*Interstitial water, \*Landslides, \*Model studies, \*Pore pressure, \*Slope stability, \*Soil mechanics, Expansive clays, Italy, Mathematical models, Piezometers, Soils.

Recent investigations indicate a growing interest in the relationship of pore pressure fields and slope stability in clay formations, particularly with re-spect to delayed failure. A simple one-dimensional

model developed to examine the pore pressure response of a saturated soil mass of finite thickness. response of a saturated soil mass of finite thickness, subject to a constant rate of erosion, suggests that the valley bottom of some American and Canadian rivers could still be subject to vertical swelling deformations from geological erosion. A clay for-mation near the town of Bisaccia in the Italian Appenines provides a test of this model; the valleys mation near the town of Bisaccia in the Italian Appenines provides a test of this model; the valleys are subject to progressive widening due to sliding phenomena. Both in situ and laboratory tests were conducted to investigate the subsoil structure, soil properties, and groundwater regime. Good quality undisturbed samples have been collected and tested for plasticity, shrinkage limit, compressibility, and swelling index. Pore pressure fields were determined by installing a number of Casagrande piezometers and vibrating wire piezometric cells. The data indicate that the superficial debris cover may be considered as a water reservoir characterized by an almost constant piezometric head every close to the ground surface. In the underlying clay materials, the piezometric head is almost constant with time, and gradually decreases with depth. Excluding the presence of a deep draining layer, this confirms the hypothesis that the present pore pressure field is a consequence of the still active erosion phenomena. Application of the one-dimensional model to the data obtained in the clay results in a model swelling coefficient of 0.03 sq m/yr, consistent with the laboratory results. in a model swelling coefficient of 0.03 sq m/yr, consistent with the laboratory results. (Tappert-PTT) W91-02149

OBSERVATIONS ON THE DEVELOPMENT OF PORE-WATER STRESSES DURING PIE-ZOCONE PENETRATION IN CLAYS. Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering. For primary bibliographic entry see Field 7B. W91-02938

SIMULATION OF DOWNHOLE AND CROSSHOLE SEISMIC TESTS ON SAND USING THE HYDRAULIC GRADIENT SIMILITUDE

British Columbia Univ., Vancouver. Dept. of Civil Engineering. For primary bibliographic entry see Field 7B. W91-02939

COMPRESSIVE STRENGTH BEHAVIOR OF FINE-GRAINED FROZEN SOILS, Calgary Univ. (Alberta). Dept. of Civil Engineer-

ing. H. Wijeweera, and R. C. Joshi. Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 4, p 472-483, August 1990. 14 fig, 4 tab, 18

Descriptors: \*Compressive strength, \*Frozen soils, \*Mathematical mc^lels, \*Soil physical properties, \*Soil strength, \*Soil temperature, \*Soil texture, \*Soil water, Frozen ground, Particle size, Stress.

Constant strain-rate (0.01/s) uniaxial compressionstrength tests were conducted on more than 200
saturated samples of six fine-grained frozen soils at
temperatures between -5 and -17 C. Saturated soil
samples containing total water contents between
15% and 105% were prepared using a consolidation apparatus specially designed for this purpose.
The effect of dry unit weight, total water content,
temperature, and soil type on the behavior of peak
compressive strength was studied. Test results indicate the peak compressive strength of fine-grained
soils was sensitive to changes in the dry unit
weight and the total water content. The temperature dependence of the peak compressive strength
is represented by a simple power law. An empirical
formula was developed to predict the peak compressive strength of fine-grained frozen soils at a
particular temperature using index properties, specific surface area, particle-size distribution, and dry
unit weight. A linear relationship existed between
the peak compressive stress and the yield stress.
However, more experimental studies are necessary
to understand clearly the compressive-strength behavior of fine-grained frozen soils with very high
dry unit weights. (Author's abstract)
W91-02940 Constant strain-rate (0.01/s) uniaxial compressi

HYDRAULIC FRACTURE IN EARTH AND ROCK-FILL DAMS.

Construction of Western Ontario, London. Faculty of Engineering Science.

For primary bibliographic entry see Field 8A.

W91-02942

# 8E. Rock Mechanics and Geology

GEOPHYSICAL INVESTIGATION-SOUTH-WESTERN GREAT ARTESIAN BASIN.

C. D. Cockshell.

Mines and Energy Review South Australia, No. 157, p 62-67, 1990. 7 fig, 5 ref.

Descriptors: \*Aquifer characteristics, \*Aquifer systems, \*Australia, \*Geophysical Aquifers, Bedrock, Confined aquifers, Geophydrology, Geologic formations, Geologic fractures, Great Artesian Basin, Lake Eyre South, Resistivity, Seismic exploration.

Three geophysical surveys near Lake Eyre South, have indicated complex structural controls affecting the Cretaceous-Jurassic aquifer sequence along the southwestern margin of the Great Artesian Basin. Seismic surveys in 1985 and 1987 indicated that northwesterly trending Adelaidan bedrock highs, bounded by a system of northwest-southeast trending faults, extend into the basin. Bedrock shale, siltstone and quartzite are generally impervious except where fractured by faulting and weathering. Over these highs the aquifer sequence can be moderately well developed, but heavily faulted such as between Roxby Management Services Borefield A and its associated 'northeastern sub-basin'. Alternatively, it can be thinly developed, lenticular or absent altogether, such as northeast of the Borefield 'sub-basin' and southwest of Lake Eyre South. These restrictions on aquifer development subsequently control aquifer recharge to the basin margins as shown by the southeasterly recharge direction into Borefield A. Electromagnetic and electrical resistivity data provided information on thickness and resistivities of the near-surface layers and on the resistivity of Bulldog Shale, which overlies the aquifer sequence. However, very low resistivities of units above the aquifer severely affect the penetration of these methods and hence limit the confidence of interpreting aquifer and bedrock parameters. (Author's abstract)

#### 8F. Concrete

RELATIONSHIP OF RESERVOIR BIOGEO-CHEMICAL PROCESSES TO THE STRUCTUR-AL INTEGRITY OF THE WORLD'S FIRST TO-TALLY ROLLER COMPACTED CONCRETE

Army Engineer District, Portland, OR. Reservoir Regulation and Water Quality Section.

Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 3, p 949-964, 1990. 9 fig, 5 tab, 12 ref.

Descriptors: \*Concrete dams, \*Concrete technology, \*Corrosion, \*Dam failure, \*Geochemistry, \*Limnology, \*Phytoplankton, \*Reservoirs, \*Sepage, \*Sulfur bacteria, Aeration, Grouting, Hydrogen sulfide, Lime, Oregon, Oxygen, Sulfuric acid, Willow Creek Dam.

Willow Creek Dam is a U.S. Army Corps of Engineers flood-control project located on a tributary of the Columbia River in Oregon. This project, completed in 1983, is the world's first dam to be built entirely with roller compacted concrete. The dam is 550 m long and 50 m high (streambed to dam crest). Willow Creek Reservoir is extremely eutrophic and is well stratified thermally during the summer. By August, the reservoir's hypolimical is well as the concentration of the concentrations. ly eutrophic and is well stratified thermally during the summer. By August, the reservoir's hypolim-nion is anoxic and contains high concentrations of hydrogen sulfide and other chemically reduced substances. Heavy phytoplankton blooms, princi-pally of Aphanizomenon flos-aquae, aggravate water quality problems in the impoundment. Ap-parent defects in the dam's concrete matrix have

provided avenues for substantial leakage of hypolimnetic waters. Seepage entering the dam's tunnels and gallery is highly enriched with hydrogen namels and gallery is highly earliched with hydrogen sulfide and dissolved lime. There is concern that oxidation of hydrogen sulfide by chemosynthetic bacteria, producing sulfuric acid, is corroding the dam's concrete. Extensive deposition of calcium carbonate on the gallery walls and floor suggests that deterioration of the concrete is occurring. Studies are underway on the geochemistry, microbiology, and hydrodynamics of seepage waters to determine whether the structural integrity of the dam is in fact at risk. Methods under study to solve this problem include hypolimnetic aeration to maintain deepwater oxygen during summer, thus preventing the buildup of hydrogen sulfide, and further injection of cement grout into the concrete matrix to hopefully arrest the seepage. (Author's abstract) W91-02399

SURFACE TREATMENTS TO MINIMIZE CONCRETE DETERIORATION, REPORT 2: LABORATORY EVALUATION OF SURFACE TREATMENT MATERIALS.

TREATMENT MATERIALS.

Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.

T. B. Husbands, and F. E. Causey.

Available from the National Technical Information Service, Springfield, VA 22161. Technical Report REMR-CS-17. September 1990. Report 2 of a Series. 102 p, 25 fig. 26 tab, 18 ref.

Descriptors: \*Concrete testing, \*Concretes, \*Maintenance, \*Materials testing, Concrete structures, Freeze-thaw tests, Polymers, Polypropylene, Shotcrete Weathering

In 1984, the US Army Corp of Engineers initiated a research program designated Repair, Evaluation, Maintenance, and Rehabilitation (REMR). One of the REMR work units was the evaluation of sur-face treatments to minimize concrete deterioration. ner REMIK WORK units was the evaluation of surface treatments to minimize concrete deterioration.

Many of the Corp's hydraulic structures have experienced concrete surface deterioration due to: (1) freezing and thawing, (2) aggressive chemical exposure, and (3) erosion. Surveys by Corp personnel have shown that freezing and thawing was the major contributing factor to concrete surface deterioration followed by erosion. Many different types of surface treatments were evaluated under this work unit including concrete sealers, coatings, polymer systems, thin overlays, and shotcrete. Emphasis was placed on materials that could be applied to the surface to reduce or prevent damage to concrete by freezing and thawing. Polymer systems for sealing cracks by topical application and elastomeric coatings for coating cracked concrete were evaluated. Other coatings for protecting concrete from erosion, chemical attachment, and grafiti were also evaluated. The siloxanes showed promise as a generic type of sealer for concrete and clay bricks on all tests, excent for resistance to fiti were also evaluated. The siloxanes showed promise as a generic type of sealer for concrete and clay bricks on all tests, except for resistance to freezing and thawing. Some of the elastomeric acrylic coatings can be used for coating cracked concrete if the cracks are narrow (hairline), based on good weatherability, elastomeric properties, and breathability of these coatings. The addition of latex admixtures to shotcrete improves the freezethaw durability of the material. Polypropylene fibers appear to reduce drying/cracking of latexmodified shotcrete. (See W90-3759 and W87-03318) (Lantz-PTT)

# 8G. Materials

MONITORING SYSTEM FOR DETECTING MOVEMENTS OF PENSTOCK SUPPORTS. Waagner-Biro A.G., Graz (Austria). Research and Development Centre.

G. Rop, and M. Bobik

International Water Power and Dam Construction IWPCDM, Vol. 42, No. 9, p 23-25,28, September

Descriptors: \*Dam construction, \*Dams, \*Measuring instruments, \*Monitoring, \*Penstocks, \*Seismic properties, Data acquisition, Hydroelectric plants, Kokluce Hydropower Station, Movement

#### Field 8—ENGINEERING WORKS

## Group 8G-Materials

detection, Penstock supports, Strain gages,

A monitoring system for the detection of movement of pensiock supports was developed for the Kokluce hydropower station, located in a seismic area in eastern Turkey. Wire strain gauges are attached to the pensiocks in the areas of maximum tensile strength and compressive stresses and are compensated for temperature by the half-bridge circuit method. The monitoring system comprises three data acquisition and control units, in which the analog data from the strain gauge amplifiers are converted to digital values, a data logger, a printer and an alarm. The normal working order of the powerplant with a capacity of 60 MW was used as the reference load condition. As the monitoring system covers a length of almost 2 km, overvoltage and lightning protection are important parts of the system. Since beginning operation at the end of 1988, no hardware or software problems have occurred. Advantages of the system include reliabilcurred. Advantages of the system include reliability, low cost, and suitability for retrofitting at completed and operating stations. (MacKeen-PTT)

EFFECTS OF FLOW DISTURBANCES ON THE ACCURACY OF TURBINE-TYPE WATER ACCURACY OF

For primary bibliographic entry see Field 7B. W91-02143

IMPACT OF HANDPUMP CORROSION ON WATER QUALITY.
International Bank for Reconstruction and Devel-

ent, Abidjan (Ivory Coast). Regional Water

and Sanitation Group.
For primary bibliographic entry see Field 5F.
W91-02338

SURFACE TREATMENTS TO MINIMIZE CONCRETE DETERIORATION. REPORT 2: LABORATORY EVALUATION OF SURFACE TREATMENT MATERIALS.

Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.

For primary bibliographic entry see Field 8F. W91-02611

### 8I. Fisheries Engineering

OCCURRENCE, RELATIVE ABUNDANCE, AND SIZE OF LANDLOCKED SEA LAMPREY (PETROMYZON MARINUS) AMMOCOETES IN RELATION TO STREAM CHARACTERIS-TICS IN THE GREAT LAKES.

Department of Fisheries and Oceans, Sault Ste. Marie (Ontario). Great Lakes Lab. for Fisheries

and Aquatic Sciences.
For primary bibliographic entry see Field 2H.
W91-02068

LAKE ACIDIFICATION AND FISHERIES PROJECT: BROOK TROUT (SALVELINUS FONTINALIS) EARLY LIFE STAGES.
Wyoming Univ., Laramie. Fish Physiology and

For primary bibliographic entry see Field 5C. W91-02102

FACTORS INFLUENCING COMMUNITY STRUCTURE AND DISTRIBUTION OF DIFFERENT LIFE-CVLE CATEGORIES OF FISHES IN SHALLOW WATERS OF A LARGE

AUSTRALIAN ESTUARY.

Murdoch Univ. (Western Australia). School of Biological and Environmental Sciences.

For primary bibliographic entry see Field 2L.

W91-02123

TIDAL AND TURBIDITY EFFECTS ON THE SHALLOW-WATER FISH ASSEMBLAGE OF

Kuwaft Bay. Kuwait Univ., Safat. Dept. of Zoology. For primary bibliographic entry see Field 2L.

W91-02126

SALMON AND THE SNAKE: MEETING FISH FLOW OBJECTIVES IN A SEMI-ARID RIVER

Watershed Resources, Inc., Santa Fe, NM. For primary bibliographic entry see Field 6D. W91-02279

INFLUENCE OF CAGE REARING PISCICUL-TURE ON WATER QUALITY AND BOTTOM SEDIMENTS IN ARTIFICIAL LAKES.

KNIPIBKS Vodokanalproject, Sofia (Bulgaria). Dept. of Scientific and Technological Research. For primary bibliographic entry see Field 5C. W91-02393

EXPERIMENTAL COMPARISON OF THE EF-FECTS OF BENTHIVOROUS FISH AND PLANKTIVOROUS FISH ON PLANKTON COMMUNITY STRUCTURE.

Oklahoma Univ., Norman. Dept. of Zoology. For primary bibliographic entry see Field 2H.

FOODWEB RESPONSE TO THE EXPERIMENTAL MANIPULATION OF A BENTHIVORE (CYPRINUS CARPIO), ZOOPLANKTIVORE (MENIDIA BERYLLINA) AND BENTHIC IN-

Oklahoma Univ., Kingston. Biological Station. For primary bibliographic entry see Field 2H. W91-02453

FIELD STUDY OF THE EFFECTS OF WATER TEMPERATURE, DISCHARGE AND TROUT ODOUR ON THE DRIFT OF STREAM INVER-TERRATES.

Toronto Univ. (Ontario). Div. of Life Sciences. For primary bibliographic entry see Field 2H. W91-02454

TURBINE-INTAKE FISH-DIVERSION

Journal of Hydraulic Research, Iowa City.
A. J. Odgaard, R. A. Elder, and D. Weitkamp.
Journal of Hydraulic Engineering (ASCE)
JHENDS, Vol. 116, No. 11, p 1301-1317, November 1990. 7 fig, 1 tab, 5 ref. Public Utility District of Grant County, Washington contract No. 430-209; Ebasco Services, Inc., Bellevue, Washington contract No. ES-7264.

Descriptors: \*Fish guiding, \*Fish management, \*Fish passages, \*Hydraulic engineering, \*Turbines, Field tests, Fish migration, Hydroelectric plants, Intake gates, Salmon, Washington.

A promising method for protecting downstream-A promising method for protecting downstream-migrating juvenile fish form death or injury due to passage through hydroelectric turbines is diversion by screening in the turbine intakes. A fish-diver-sion system was developed to be used in the tur-bine intakes of the Wanapum and Priest Rapids developments on the Columbia River, in the state of Washington. The system uses a passive-bar screen, installed through the emergency gate well, to produce a flow pattern that deflects down-stream-migrating juvenile salmonids into the gate stream-migrating juvenile salmonids into the gate well for subsequent removal and bypass to below the dam. The system is based on laboratory model studies and field tests. The model studies provide data on the hydraulic performance of the system and result in an understanding of the hydraulic features of the technique, which can be a guide for future designs. The studies also serve as a guide to development of the structural design of the system. The design, field tested in 1986, 1987, and 1988, attains a fish-guidance efficiency of about 68% with a minimal of descaling (removal of fish scales by abrasion). (Author's abstract) W91-02915

## 9. MANPOWER, GRANTS AND FACILITIES

#### 9A. Education (Extramural)

WILLIE TAKES A FIELD TRIP COLORING

Geological Survey, Indianapolis, IN. Water Resources Div. D. V. Arvin.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-125, August 1990. 37p, 37 fig.

Descriptors: \*Children's educational material, \*Data acquisition, \*Hydrologic data, \*Indiana, \*Publications, Field tests, Field trip.

This coloring book is an educational tool designed to instruct children on some of the field activities commonly associated with the collection of water commonly associated with the collection of water resource data. Through the use of line drawings and brief descriptive text, young readers will follow little Willie and his Uncle Bill as they spend a pleasant day in the field measuring streamflow, collecting sediment samples, making groundwater measurements at observation wells, and measuring flow in a pipe. Although this 37-page coloring book is geared to children 5 to 10 years old, people of all ages may find it enjoyable. (USGS) W91-02251

#### 9C. Research Facilities

WATER RESOURCES ACTIVITIES IN FLORI-

DA, 1989-90. Geological Survey, Tallahassee, FL. Water Re-

For primary bibliographic entry see Field 7C. W91-02258

### 9D. Grants, Contracts, and Research Act Allotments

WATER RESEARCH IN AUSTRALIA: CUR-RENT PROJECTS 1989.

Department of Primary Industries and Energy, berra (Australia). Australian Government Publishing Service, Canberra, Australia. 1990. 163 p.

Descriptors: \*Australia, \*Bibliographies, \*Foreign research, \*Water resources research, Annual reports, Data collections, Research facilities.

This Annual Publication incorporates about 1000 summaries of water-related research projects currently being undertaken in Australia by individuals and research organizations. Research projects are grouped according to broad subject categories, and within these are listed in alphabetical order by project title. Two indexes allow retrieval by the names of members of the research team and the organizations carrying out or sponsoring the research, and by subject, using terms from the Aqualine thesaurus and additional Australian terms. Information included in this sublication is taken from This Annual Publication incorporates about 1000 formation included in this publication is taken from the Australian computerized data base, Streamline. (Author's abstract) W91-02612

### 10. SCIENTIFIC AND TECHNICAL INFORMATION

## 10C. Secondary Publication And Distribution

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN KANSAS-FISCAL YEARS 1987 AND 1988. Geological Survey, Lawrence, KS. Water Re-

# Preparation Of Reviews—Group 10F

For primary bibliographic entry see Field 7C. W91-02236

BIBLIOGRAPHY OF U.S. GEOLOGICAL SURVEY REPORTS ON THE WATER RESOURCES OF FLORIDA, 1886-1989.
Geological Survey, Tallahassee, FL. Water Re-

sources Div.

sources Div.

T. L. Embry, and N. D. Hoy.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS
Open-File Report 90-143, 1990. 196p, 1 fig. Project No. FL-002.

Descriptors: \*Bibliographies, \*Florida, \*Ground-water, \*Surface water, \*Water quality, \*Water re-

The U.S. Geological Survey has released a listing of its reports on water resources in Florida for the period 1886-1989. Most of the reports contained in the listing were prepared by the U.S. Geological the insung were prepared by the U.S. Geological Survey in cooperation with numerous public agencies in Florida. The compilation has a full bibliographic list of reports arranged alphabetically by senior author. In addition, the reports are indexed by geographic areas and by subject. (USGS) W91-02237

ACTIVITIES OF THE ALASKA DISTRICT, WATER RESOURCES DIVISION, U. S. GEO-LOGICAL SURVEY, 1990. Geological Survey, Anchorage, AK. Water Resources Div.

For primary bibliographic entry see Field 7C. W91-02259

CIEH'S CONTRIBUTION TO THE DEVELOP-MENT OF HYDROLOGY IN ARID AND SEMI-

ARID AREAS IN AFRICA (CONTRIBUTION DU CIEH AU DEVELOPPEMENT DE L'HY-DROLOGIE DANS LES ZONES ARIDES ET SEMI-ARIDES D'AFRIQUE).

Comite Interafricain d'Etudes Hydrauliques, Oua-gadougou (Burkina Faso). Dept. of Hydrology. For primary bibliographic entry see Field 2A. W91-02292

WETLAND AREAS: NATURAL WATER TREATMENT SYSTEM (JAN 78 - AUG 89), CITATIONS FROM THE POLLUTION ABSTRACTS DATABASE.

Davis (J.J.) Associates, Inc., McLean, VA. For primary bibliographic entry see Field 5D. W91-02642

SEWAGE SLUDGE: APPLICATION TO SOILS (JAN 85 - JUL 89). CITATIONS FROM THE BIOBUSINESS DATABASE.
Davis (J.J.) Associates, Inc., McLean, VA.
For primary bibliographic entry see Field 5E.
W91-02648.

WASTEWATER TREATMENT: CHEMICAL IN-WASTEWATER TREATMENT: CHEMICAL IN-DUSTRY (JAN 70 - SEP 89), CITATIONS FROM THE POLLUTION ABSTRACTS DATABASE. Davis (J.J.) Associates, Inc., McLean, VA. For primary bibliographic entry see Field 5D. W91-02644

PULPING EFFLUENTS: BIOLOGICAL TREAT-MENT (JAN 76 - SEP 89). CITATIONS FROM THE PAPER & BOARD, PRINTING & PACK-AGING INDUSTRIES RESEARCH ASSOCIA-TION.

Davis (J.J.) Associates, Inc., McLean, VA. For primary bibliographic entry see Field 5D.

W91-02645

DRINKING WATER QUALITY STANDARDS AND STANDARD TESTS (JAN 72 - MAY 89), CITATIONS FROM THE FOOD SCIENCE AND TECHNOLOGY ABSTRACTS DATABASE, Davis (J.J.) Associates, Inc., McLean, VA For primary bibliographic entry see Field 5F. W91-02646

HEAVY METALS IN DRINKING WATER: STANDARDS, SOURCES, AND EFFECTS (JAN 78 - SEP 89). CITATIONS FROM THE LIFE SCIENCES COLLECTION DATABASE. Davis (J.J.) Associates, Inc., McLean, VA. For primary bibliographic entry see Field 5F. W91-02647

# 10F. Preparation Of Reviews

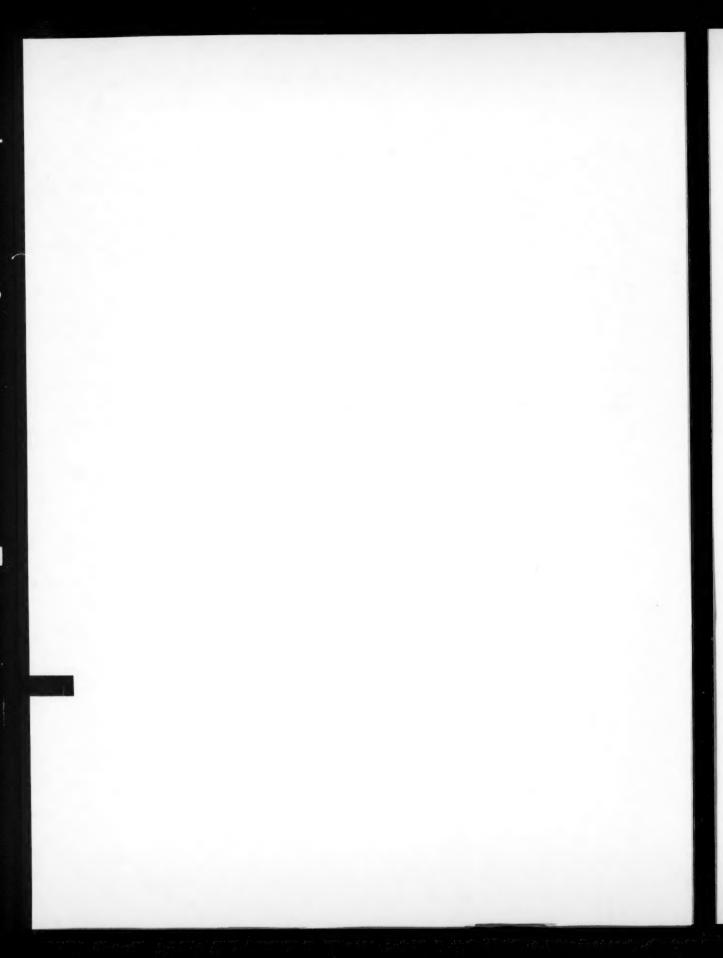
ENVIRONMENTAL CHEMISTRY AND BIO-LOGICAL EFFECTS OF CADMIUM COM-POUNDS.

International Association of Environmental Analytical Chemistry, Therwil (Switzerland).

For primary bibliographic entry see Field 5B. W91-02173

BED CONFIGURATIONS IN STEADY UNIDIR-ECTIONAL WATER FLOWS: PART II, SYN-THESIS OF FLUME DATA.

Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences. For primary bibliographic entry see Field 2E. W91-02926



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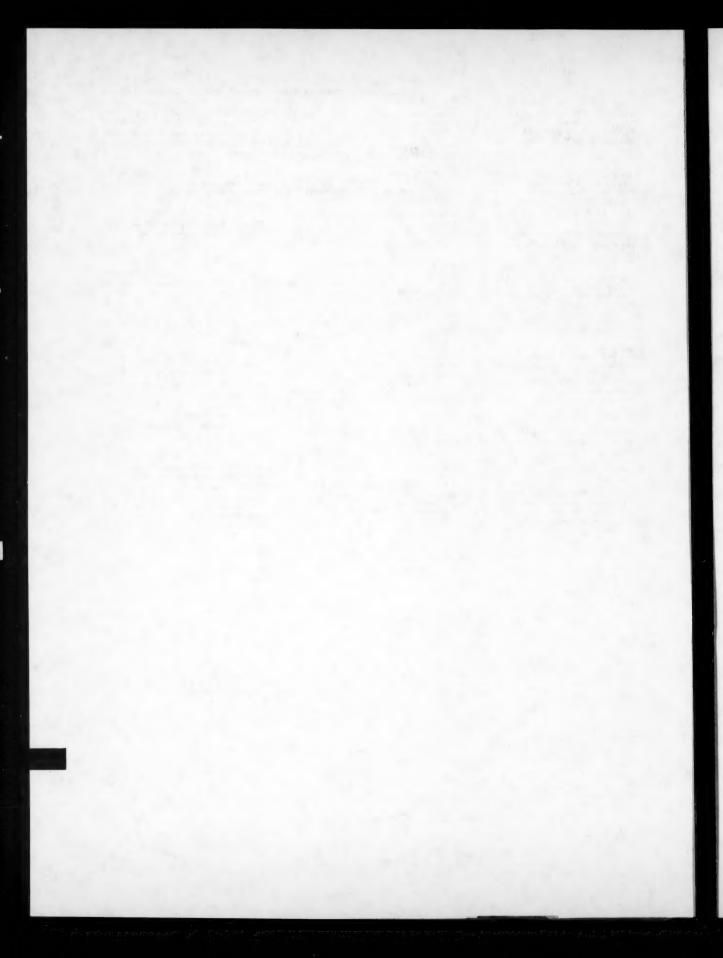
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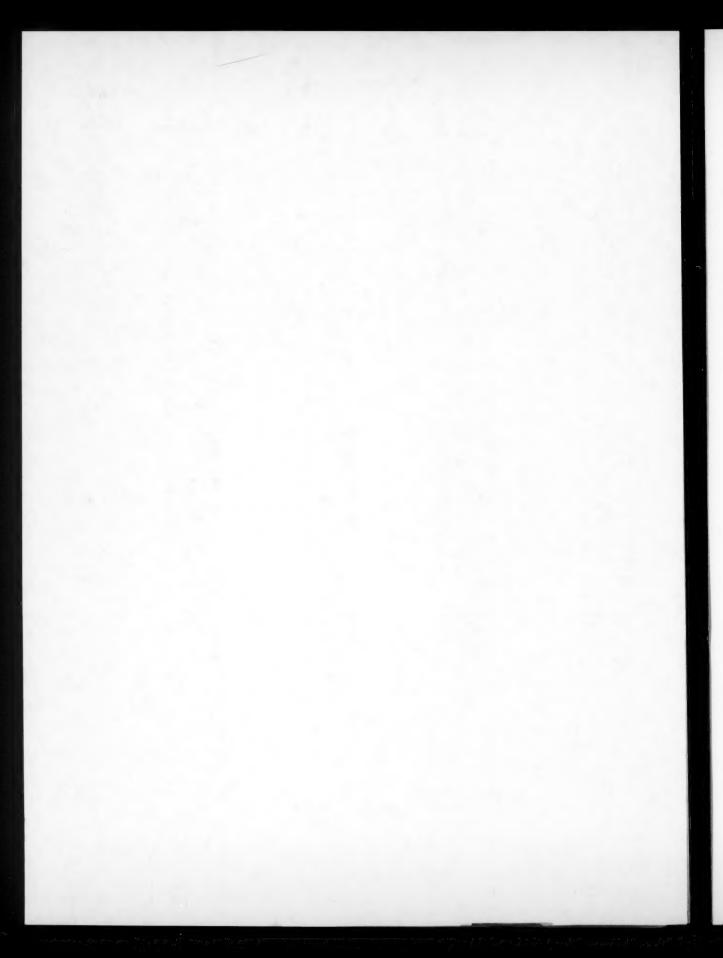
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W91-02735	5C	W91-02797	5D	W91-02859 5B	W91-02920	2E
W91-02736	2H	W91-02798	5B	W91-02860 2E	W91-02921	4C
W91-02737	5C	W91-02799	5D	W91-02861 2G	W91-02922	2E
W91-02738	5C	W91-02800	5A	W91-02862 2F	W91-02923	2.J
W91-02739	5B	W91-02801	5D	W91-02863 5F	W91-02924	8B
W91-02740	5B	W91-02802	2J	W91-02864 2F	W91-02925	2E
W91-02741	5B	W91-02803	2A	W91-02865 2E		2E
W91-02742	2K	W91-02804	7C	W91-02866 4B	W91-02926	
W91-02743	5B	W91-02805	2B	W91-02867 2F	W91-02927	2E
W91-02744	2K	W91-02806	2H	W91-02868 2E	W91-02928	2J
W91-02745	4C	W91-02807	7B	W91-02869 2E	W91-02929	2.J
W91-02746	2E	W91-02808	2E	W91-02870 7C	W91-02930	5C
W91-02747	2H	W91-02809	4C	W91-02871 5E	W91-02931	5B
W91-02748	2K	W91-02810	2K	W91-02872 2G	W91-02932	5B
W91-02749	5B	W91-02811	2A	W91-02873 2F	W91-02933	5E
W91-02750	5B	W91-02812	2J	W91-02874 2F	W91-02934	2L
W91-02751	4C	W91-02813	6D	W91-02875 2G	W91-02935	5C
W91-02752	5B	W91-02814	5B	W91-02876 2G	W91-02936	5D
W91-02753	5B	W91-02815	2K	W91-02877 2B	W91-02937	5D
W91-02754	5B	W91-02816	5B	W91-02878 2G	W91-02938	7B
W91-02755	2K	W91-02817	5F	W91-02879 7C	W91-02939	7B
W91-02756	2K	W91-02818	5B	W91-02880 7C	W91-02940	8D
W91-02757	5B	W91-02819	5A	W91-02881 5B	W91-02941	5B
W91-02758	2K	W91-02820		W91-02882 2G	W91-02942	8A
W91-02759	5B	W91-02821	2J	W91-02883 5B	W91-02943	5E
W91-02760	2B	W91-02822	5D	W91-02884 2F	W91-02944	
W91-02761	2B	W91-02823	5D	W91-02885 2H	W91-02945	2F
W91-02762	2L	W91-02824	5F	W91-02886 2B	W91-02946	
W91-02763	5D	W91-02825	5F	W91-02887 5E	W91-02947	5G
W91-02764	5D	W91-02826		W91-02888 2K	W91-02948	
W91-02765	5A	W91-02827		W91-02889 2K		
W91-02766	2H	W91-02828		W91-02890 2K	W91-02949	
W91-02767	2F	W91-02829		W91-02891 5B	W91-02950	
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W91-02771	5B	W91-02833		W91-02895 5G	W91-02954	
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W91-02773	5D	W91-02835		W91-02897 5G	W91-02956	
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# Subject Fields

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- WATER QUALITY MANAGEMENT 5 AND PROTECTION
- WATER RESOURCES PLANNING
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- MANPOWER, GRANTS, AND 9 **FACILITIES**
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#### 1991 Price Schedules for the United States, Canada, and Mexico

These prices are for customers in the United States, Canada, and Mexico; other customers, write for price list PR-360-4.

# Microfiche & Paper Copy Reports Computer Products

Standard Prices	Exception Prices	Diskettes	Magnetic Tapes
A01\$8.00	E01\$10.00	D01\$50	T01\$165
A02 11.00	E02 12.00	D0280	T02220
A03 15.00	E03 14.00	D03130	T03340
A04-A05 17.00	E04 16.50	D04180	T04 450
A06-A09 23.00	E05 18.50	D05230	T05 560
A10-A13 31.00	E0621.50	D06280	T06 670
A14-A17 39.00	E07 24.00	D07330	T07780
A18-A21 45.00	E08 27.00	D08380	T08 890
A22-A25 53.00	E09 29.50	D09430	T09 1,000
A99	E10 32.50	D10480	T10 1,110
	E11 35.00	D11530	T111,220
	E1238.50	D12580	T12 1,330
"N" Codes	E13 41.00	D13630	T13 1,440
N01\$60.00	E14 45.00	D14680	T14 1,550
N0259.00	E15 48.50	D15730	T15 1,660
N0320.00	E16 53.00	D16780	T161,770
	E17 57.50	D17830	T17 1,880
	E18 62.00	D18880	T181.990
	E19 69.00	D19930	T192,100
	E20 80.00	D99	T99
	E99*		

\* Contact NTIS for price

Prices effective January 1, 1991

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